2003 SUMMARY REPORT
of
WOOSTER LAKE

Lake County, Illinois

Prepared by the

LAKE COUNTY HEALTH DEPARTMENT
ENVIRONMENTAL HEALTH SERVICES
LAKES MANAGEMENT UNIT
3010 Grand Avenue
Waukegan, Illinois 60085

Michael Adam
Christina L. Brant
Mary Colwell
Joseph Marencik
Mark Pfister

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EXECUTIVE SUMMARY

Wooster Lake is a natural glacial lake, encompassing approximately 98.9 acres and a shoreline length of 2.03 miles. It is part of the Fish Lake drainage of the Fox River watershed. Water clarity, as measured by Secchi disk transparency readings, averaged 7.83 feet for the season, which is above the county median (where 50% of the lakes are above and below this value) of 3.41 feet. The 2003 average is down slightly from the 1999 average of 8.00 feet, but significantly better than the other lakes in the Fish Lake Drain.

Total phosphorus (TP) concentrations in the epilimnion of Wooster Lake were low. The 2003 average TP concentration was 0.032 mg/L in the epilimnion, which is lower than the county median of 0.059 mg/L. The 2003 average is slightly higher than the 1999 and 1995 epilimnetic averages of 0.027 mg/L and 0.024 mg/L, respectively.

Two parameters that appear to be increasing in Wooster Lake are the total dissolved solid (TDS) concentrations and conductivity readings in both the epilimnion and hypolimnion. The 2003 average TDS concentrations and conductivity readings have increased from the 1995 and 1999 averages. The most likely cause of this increase is the increase in dissolved solids, particularly road salt.

The data from the Holiday Park inlet samples were nearly identical to the averages in the epilimnion in the main body of the lake. It appears that the sediment curtains that were installed in this channel are working properly and preventing large amounts of sediment from entering the lake.

Wooster Lake has a good aquatic plant community. Nineteen aquatic plant species and several emergent shoreline plants were found. Whitestem pondweed, an endangered species in Illinois, was found scattered throughout the lake. Coontail was the dominant plant in Wooster Lake in 2003 being found at 85% of all sites. Eurasian water milfoil (EWM), an exotic, and sago pondweed were the next most common plants comprising 48% and 40% of all samples, respectively. Using Global Positioning System (GPS) technology, the maximum visible plant coverage was calculated to be 41.6 acres (42% of the surface area of the lake) in June. A detailed aquatic plant management plan should be incorporated into the overall lake management plan, with emphasis on controlling EWM, while maintaining the native plant populations.

Approximately 70% of the shoreline of Wooster Lake was classified as developed. Shrub habitat was the most common shoreline type comprising 22% of the shoreline. The next most common shoreline types were lawn (15%), wetland (15%), buffer (14%), and beach (12%). The shoreline was assessed for the degree and type of shoreline erosion. Approximately 31% or 2,994 feet of the shoreline was classified as slightly eroding and 4% or 411 feet was moderately eroding. No areas of the lake were classified as having severe erosion. Several exotics were found growing along the shoreline, including buckthorn, reed canary grass, and common reed. Removal or control of exotic species is recommended.

LAKE IDENTIFICATION AND LOCATION

Wooster Lake (T45N, R9E, Section 23) is located south of State Highway 134 and west of Wilson Road in unincorporated Ingleside (Grant Township). It is part of the Fish Lake drainage of the Fox River watershed. The Fish Lake Drain flows from Fish Lake into Fischer Lake then into Wooster Lake. Water leaves Wooster Lake by a small creek along the northern shoreline and flows into Duck Lake, eventually draining into the Fox River. Wooster Lake's immediate watershed is approximately 4,657 acres (Figure 1), with a watershed to lake ratio of 47:1.

Wooster Lake encompasses approximately 98.9 acres and has a shoreline length of 2.03 miles. A 1971 bathymetric (depth contour) map of the main body of the lake indicates the maximum depth to be 28 feet, with an average depth of 16.3 feet, and the volume of the lake to be 1,634.9 acre-feet (Figure 2). In 2003 we found the maximum depth to be 29.8 feet. Lake elevation is approximately 750 feet above sea level.

Wooster Lake is listed as an ADID (advanced identification) wetland by the U.S. Environmental Protection Agency (USEPA). This indicates that the lake and surrounding natural environments have potential to have high quality aquatic resources. The lake is also on the Illinois Department of Natural Resources (IDNR) Natural Area Inventory (NAI).

BRIEF HISTORY OF WOOSTER LAKE

Wooster Lake is a natural glacial lake resulting from the last glaciation several thousand years ago. As the glacier receded from the county it left numerous lakes and wetlands.

Figure 3 shows the Wooster Lake area in a 1939 aerial photograph.

SUMMARY OF CURRENT AND HISTORICAL LAKE USES

Wooster Lake has been an important part of the social and economic climate of the area for a long time. Fish and wildlife were reported to be plentiful in and around the lake during European settlement of the area. It was likely important to native Indian cultures as well. Much of the documented uses of the lake begin in the late 1800's. Recreational activities such as fishing and boating have always been part of the lake usage.

The major land use in the Wooster Lake watershed (based on 2000 land use maps) is agriculture (44.0%), followed by forest and grassland (11.7%; Figure 4 and Table 1,

Figure 1. Watershed.

Figure 2. 1971 bathymetric map of Wooster Lake.

Figure 3. 1939 photograph.

Figure 4. Land uses.

Appendix A). All of the remaining types each consist of less than 10% of the land uses in the watershed. The type and composition of the land uses in the watershed may have an impact on a number of water quality issues related to the overall health of the lake.

We monitored the beach at Camp Henry Horner bimonthly for *E. coli* bacteria from early May to Labor Day. Results of the 2003 beach sampling will be discussed in the body of this report. Other access points include: Burkhart Lane, Holiday Park, Schumacher's Subdivision, Forest Avenue Beach, Tanneron Bay Subdivision, and Park Avenue Beach. There are no public access points on Wooster Lake.

There have been no whole-lake herbicide treatments of Wooster Lake. However, several homeowners did treat near shore areas along the eastern side of the lake in 2003. In addition, limited aquatic plant harvesting occurred in the 1990s. Details of herbicide use on the lake will be discussed in the **Aquatic Plant Assessment** section of this report.

We have conducted water quality studies on Wooster Lake in 1989, 1995, and 1999 in addition to this year, as well as Fish Lake (which drains into Fischer Lake) in 2002 and Fischer Lake (which drains into Wooster Lake) and Duck Lake (immediately downstream of Wooster Lake) in 2001. Details of these studies will be discussed in the body of this report.

LIMNOLOGICAL DATA – WATER QUALITY

Water samples were collected monthly from May - September at the deep-hole location near the center of the lake (Figure 5). In response to concerns regarding the Holiday Park development on the west side of the lake, we collected additional water samples from the channel where stormwater from the subdivision enters the lake. See Appendix B for water sampling methods.

Wooster Lake's water quality is better than many lakes in Lake County (Table 2 in Appendix A). Most of the water quality parameters measured were below the averages of other lakes that we have monitored. Several important findings were noted.

Water clarity, as measured by Secchi disk transparency readings, averaged 7.83 feet for the season, which is above the county median (where 50% of the lakes are above and below this value) of 3.41 feet. Significant changes occurred early in the season with the deepest reading recorded in May (14.08 feet) and the shallowest reading recorded in June (4.33 feet). This one-month decline was due to a severe planktonic algae bloom that was occurring at the time of the June sample. A similar pattern was seen in 1999 when the May reading (12.80 feet) was followed by a significant decline in June (4.30 feet). The 2003 average is down slightly from the 1999 average of 8.00 feet. The Volunteer Lake Monitoring Program (VLMP) has been continuously active on the lake since 1995 (data was also recorded in 1992). These historical results can be seen in Figure 6 below and in Table 3 in Appendix A. This program has been very successful and should continue in the future as any trends in clarity can be ascertained from multiple years of data. The

Figure 5. Sample location.

Figure 6. Secchi readings

differences between VLMP data and our data, as seen in Figure 6, can be attributed in part to variability among individuals observing the Secchi disk, the time of year, and number of the readings. We determined during our assessments of the other lakes in the Fish Lake Drain that we have studied recently, Fish Lake (which flows into Fischer Lake) had an average Secchi reading of 4.02 feet in 2002, Fischer Lake (which flows into Wooster Lake) had an average Secchi reading of 2.72 feet in 2001. Duck Lake, which is immediately downstream of Wooster Lake, had an average Secchi reading of 2.01 feet in 2001. Wooster Lake has the best water clarity in this chain of lakes due mostly to its deeper depth (29.75 feet), larger volume (1634.9 acre-feet), and better aquatic plant populations than Duck, Fish, or Fischer Lakes (see Table 4 in Appendix A for a comparison of the Secchi readings and other parameters among these lakes). It should also be noted that, as mentioned earlier, the major land use in the Wooster Lake watershed is agriculture. Both past and present agricultural practices may have resulted in large amounts of nutrients moving through this watershed.

Although there has been a slight decline, the good water clarity in Wooster Lake is also attributed to the low concentrations of total suspended solids (TSS) found in the lake. The 2003 average TSS concentrations in the epilimnion (3.4 mg/L) was lower than the county median (7.5 mg/L). Based on data we collected in 1995 and 1999, the average TSS concentrations in the epilimnion have remained relatively stable. The 1999 and 1995 epilimnion averages were 4.3 mg/L and 1.82 mg/L, respectively. Similarly in the hypolimnion, the 2003 average concentration was 5.6 mg/L compared to the 1999 and 1995 hypolimnion averages of 5.4 mg/L and 4.0 mg/L, respectively. The VLMP has also collected TSS data in 1992, 1996-1998, and 2000-2002 (Table 5 in Appendix A), however the average for the seven years in this program was 6.4 mg/L compared to our average of 3.2 mg/L (1995, 1999, and 2003 data). Combining the VLMP data with our data, the TSS average concentration in the epilimnion is 5.5 mg/L.

The lake was not stratified during the May sampling date. A thermocline was established at 10 feet in June, 14 feet in July, and 12 feet in August. By the September sampling date the thermocline was beginning to dissipate, but was still present at 24 feet. Dissolved oxygen (DO) concentrations in Wooster Lake did not indicate any significant problems. Generally concern arises when DO concentrations fall below 5 mg/L in the epilimnion. In 2003, all DO concentrations near the surface were above 5 mg/L. Anoxic conditions (where DO concentrations drop below 1 mg/L) did exist below 21 feet in May, 19 feet in June, 15 feet in July, 19 feet in August, and 23 feet in September. In order to accurately assess the DO conditions in the lake, the volume at specific depths (preferably in one or two foot increments) is needed. Since only an old bathymetric map of Wooster Lake exists, an accurate assessment of the DO conditions cannot be made. The creation of a new bathymetric map is recommended.

Total phosphorus (TP) concentrations in Wooster Lake were low. The 2003 average TP concentration was 0.032 mg/L in the epilimnion, which is lower than the county median of 0.059 mg/L. The 2003 average is slightly higher than the 1999 and 1995 epilimnion averages of 0.027 mg/L and 0.024 mg/L, respectively. The VLMP has also collected TP data in 1992,1996-1998, and 2000-2002 (Table 5 in Appendix A). The average of the seven years was 0.027 mg/L compared to our three year average of 0.028 mg/L. Combining the VLMP data with our data, the TP concentration in the epilimnion averages 0.029 mg/L. In the hypolimnion, the 2003 average TP concentration was 0.360 mg/L, compared to the county median of 0.186 mg/L. The 2003 hypolimnion average is approximately 41% lower than the 1999 average of 0.509 mg/L and approximately 23% higher than the 1995 hypolimnion average of 0.2786 mg/L. The variability in the hypolimnion may be due to annual variation or the location and strength of the thermocline. Because the epilimnion average has remained stable, the data trend observed in the hypolimnion illustrates the capacity of the lake to sequester released nutrients below the thermocline until turnover. This capacity is not seen in the other lakes in the Fish Lake Drain.

The good water quality in Wooster Lake can also be attributed to the extensive aquatic plant populations in the lake, since the plants stabilize bottom sediment and compete with algae for nutrients. Overmanagement of the plants may have serious ramifications on the concentrations of TP and other nutrients and may result in the decline in Wooster Lake's water quality to a point that mirrors Fish and Fischer Lakes. Another threat to the lake is probably fertilizer (which is often high in phosphorus) applied to the lawns near the lake. It is recommended that homeowners use a no-phosphorus fertilizer on their lawns.

Two parameters that appear to be increasing in Wooster Lake are the conductivity readings and total dissolved solid (TDS) concentrations in both the epilimnion and hypolimnion. The 2003 average conductivity reading was 0.6437 milliSiemens/cm, which is lower than the county median of 0.7503 milliSiemens/cm. However, the 1999 and 1995 average conductivity readings in the epilimnion were 0.5744 milliSiemens/cm and 0.5160 milliSiemens/cm, respectively. Upstream, both Fish and Fischer Lakes have similar average conductivity readings in the epilimnion (Fish Lake at 0.6629 milliSiemens/cm in 2002; Fischer Lake at 0.6687 milliSiemens/cm in 2001). Similarly in the hypolimnion, the 2003 average in Wooster Lake was 0.7147 milliSiemens/cm, which is below the county median of 0.7917 milliSiemens/cm, but higher than the 1999 and 1995 averages of 0.6844 milliSiemens/cm and 0.561 milliSiemens/cm, respectively. Correlated with the increase in conductivity readings are increases in TDS. While the 2003 epilimnetic TDS average (361 mg/L) was lower than the county TDS average (451 mg/L), there has been an increase from the 1999 epilimnetic average of 325 mg/L. TDS concentrations were not measured in 1995. The most probable cause of this increase in conductivity and TDS is from road salt. Some lakes in the county have seen a doubling of conductivity readings in the past 5-10 years. Because of the increasing conductivity readings, one additional parameter, chloride, was calculated based on a formula created with known chloride and total dissolved solid concentrations and conductivity readings. Chloride concentrations help determine if this was the case since most road salt is sodium chloride, calcium chloride, potassium chloride, magnesium chloride or ferrocyanide salts. The seasonal average for calculated chlorides in Wooster Lake in 2003 was 64 mg/L in the epilimnion and 89 mg/L in the hypolimnion. The Illinois Environmental Protection Agency (IEPA) standard for chloride is 500 mg/L. Once values exceed this standard the water body is deemed to be impaired, thus impacting aquatic life. In a study by Environment Canada (equivalent to our USEPA), it was estimated that 5% of aquatic species such as fish, zooplankton and benthic invertebrates would be affected at chloride concentrations of about 210 mg/l. Additionally, shifts in algae populations in lakes were associated with chloride concentrations as low as 12 mg/l. The use of road salt for winter road maintenance should be addressed.

High nutrient concentrations are usually indicative of water quality problems. Algae need light and nutrients, most importantly carbon, nitrogen (N) and phosphorus (P), to grow. Light and carbon are not normally in short supply (limiting). This means that nutrients (N&P) are usually the limiting factors in algal growth. Nitrogen, as well as carbon, naturally occur in high concentrations and come from a variety of sources (soil, air, etc.) that are more difficult to control than sources of phosphorus. To compare the availability of these nutrients, a ratio of total nitrogen to total phosphorus is used (TN: TP). Ratios < 10:1 indicate nitrogen is limiting. Ratios of >15:1 indicate phosphorus is limiting. Ratios >10:1, <15:1 indicate that there is enough of both nutrients for excessive algal growth. The average ratio between total nitrogen and total phosphorus for Wooster Lake in 2003 was 36:1, indicating a phosphorus-limited system. This is down slightly from the 1999 ratio of 48:1. Lakes that are phosphorus-limited may be easier to manage, since controlling phosphorus is more feasible than controlling nitrogen or carbon.

Water levels on Wooster Lake fluctuated throughout the season. The highest water level was found in June and the lowest level in September. The maximum one-month change occurred between August and September when the lake level dropped by 5.25 inches. The maximum change over the season (June to September) was a 18.75-inch decrease. Significant changes in water levels may have a negative impact on water quality. In addition, lakes with fluctuating water levels potentially have more shoreline erosion problems. Low water levels are a concern for many homeowners around the lake, particularly the Tanneron Bay subdivision near the outlet. Several residents are interested in determining the feasibility of replacing the current outlet structure to have more control over water levels. The current outlet structure consists of a 72" culvert with a 12" high metal spillway wall. We recommend that if a new outlet structure is installed that it have some restrictors that can be manipulated as part of the overall structure. To change the structure will require the approval of the Illinois Department of Natural Resources' Office of Water Resources (847-705-4341) and the Lake County Stormwater Mangement Commission (SMC; 847-918-5260).

Rain events may contribute additional sediment or nutrients (like phosphorus) to a lake, which may have influenced the water sample results. However, rain occurred within 48 hours prior to water sampling only in July (0.02 inches) as recorded at the Lake County Stormwater Management Commission rain gage in Wauconda. While rain events did not affect our sampling results, events do contribute sediment and nutrients to the lake from upstream sources. This is of concern due to the nutrient concentrations found in Fish Lake and Fischer Lake upstream.

The Holiday Park inlet samples results can be seen in Table 6 in Appendix A. The averages at this sample site were nearly identical to the averages in the epilimnion. It appears that the four sediment curtains that were installed in this channel are working properly and preventing large amounts of sediment from entering the lake. The water clarity was clear on the east side of the curtains during each month's visit. However, after a rain event the water clarity on the west side of the curtains was cloudy. Additional evidence of the effectiveness of the curtains was the lack of accumulated sediment on the plants east of the curtains. It is recommended that these curtains be maintained for the immediate future until the site is fully stabilized.

Based on data collected in 2003, standard classification indices compiled by the Illinois Environmental Protection Agency (IEPA) were used to determine the current condition of Wooster Lake. A general overall index that is commonly used is called a trophic state index or TSI. The TSI index classifies the lake into one of four categories: oligotrophic (nutrient-poor, biologically unproductive), mesotrophic (intermediate nutrient availability and biological productivity), eutrophic (nutrient-rich, highly productive), or hypereutrophic (extremely nutrient-rich productive). This index can be calculated using total phosphorus values obtained at or near the surface. The TSIp for Wooster Lake in 2003 classified it as a eutrophic lake (TSIp = 54.0). This is a slight decrease from the 1999 TSIp of 51.8 and 1995 TSIp of 49.9. For comparison, Fish Lake had a TSIp of 70.9 in 2002, Fischer Lake had a TSIp of 80.4 in 2001 and Duck Lake had a TSIp of 70.5 in 2001. All of these three lakes are classified as hypereutrophic. Eutrophic lakes are the most common types of lakes throughout the lower Midwest, and they are particularly common among manmade lakes. See Table 7 in Appendix A for a ranking of average TSIp values for Lake County lakes (Wooster Lake is currently #35 of 130, Fish Lake is #94, Fischer Lake is #120, and Duck Lake is #91). This ranking is only a relative assessment of the lakes in the county. The current rank of a lake is dependent upon many factors including lake origin, water source, nutrient loads, and morphometric features (volume, depth, substrate, etc.). Thus, a small shallow manmade lake with high nutrient loads could not expect to achieve a high ranking even with intensive management.

In Wooster Lake, the IEPA aquatic life impairment index was low, indicating a full degree of support for all aquatic organisms in the lake. Similarly, the good water clarity in the lake helped classified the swimming index as a full degree of support. However, due to the abundance of aquatic plants in the lake, the recreation use index showed a partial impairment. The overall use index was classified as full use.

The only beach we tested in 2003 for *E. coli* on Wooster Lake was at Camp Henry Horner. All samples in 2003 at this beach indicated low levels of *E. coli* bacteria (range 4.1-210.5 MPN per 100 ml). This beach was closed four times in 2002 and once in 2001. The new development at Holiday Park on the lake's west side will have a beach for the members of the subdivision. It is required that this beach be licensed by the Illinois Department of Public Health prior to opening and then it will become part of our bimonthly sampling program.

Lake residents have complained about getting swimmer's itch. Swimmer's itch is a skin rash caused by a parasite (shistosomes) which ordinarily infect birds, semi-aquatic mammals, and snails. As part of their developmental life-cycle, these parasites are released from infected snails, migrate through the water, and are capable of penetrating human skin. After penetration, these parasites remain in the skin and die but can cause an allergic reaction in some people. The parasite in humans does not mature, reproduce or cause any permanent infection. Swimmer's itch is most prevalent in late-spring and early summer and is naturally found in many lakes in Lake County.

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

Aquatic plant species presence and distribution in Wooster Lake were assessed monthly from May through September 2003 (see Appendix B for methods). Nineteen aquatic submersed and floating plant species and several emergent shoreline plants were found (see Table 8, below). Terrestrial shoreline plants were also noted, but not quantified.

Wooster Lake has a good aquatic plant community (Table 9 in Appendix A). Coontail was the dominant plant in Wooster Lake in 2003 being found in 85% of all samples. Eurasian water milfoil (EWM), an invasive exotic, and sago pondweed were the next most common plants comprising 48% and 40% of all samples, respectively. White water lily was found in 27% of all samples.

The fifth most common plant was whitestem pondweed, which is an endangered species in Illinois. It was found in scattered populations in the shallow areas around the lake (comprising 14% of all samples). Its presence is important for the ecological diversity of the lake. Any management activities (particularly herbicide treatments) should take into account the presence of this species.

During plant sampling, we searched for the milfoil weevil (*Euhrychiopsis lecontei*) on EWM plants. This weevil attacks the tip and stem of the plant and is currently being used as a biological control for EWM in many lakes in the Midwest. The weevil was found in Wooster Lake in 1996 naturally in many lakes. Unfortunately, no weevils were found in Wooster Lake in 2003. Weevils have also been found upstream in Fischer Lake in 2001.

The 1% light levels (the point where plant photosynthesis ceases) decreased throughout the summer with the deepest light penetration occurring in May (20 feet) and the shallowest occurring in September (12 feet). Since only an old bathymetric map of Wooster Lake exists, an accurate assessment of plant coverage based on available light levels cannot be made. However, we used Global Positioning System technology to map the visible plant coverage on June 25th when the aquatic plant coverage appeared to be at its maximum (Figure 7). The visible plant coverage was calculated to be 41.6 acres (42% of the surface area of the lake). It is noted that plants grew much deeper but were not observed at the surface so the total plant coverage of the bottom was likely greater than 42%. The Illinois Department of Natural Resources recommends 25-40% aquatic plant coverage to maintain ideal fish habitat conditions.

In 2003, some homeowners around the eastern shoreline treated part of their lake bottom with aquatic herbicides. Both liquid and granular 2,4-D products were used to control EWM, coontail, and water lilies. It is recommended that if multiple bottom owners want to treat their lake bottom in the future, that a licensed applicator be hired to conduct the

Figure 7. Max. plant coverage.

herbicide treatment. In Illinois, homeowners can treat only their own lake bottom. It is illegal to treat another lake bottom without a license from the Illinois Department of Agriculture. As mentioned previously, care should be exercised with regard to aquatic plant management in Wooster Lake, since the plants are one of the reasons the lake has such good water quality. Overmanagement of these communities would have negative impacts to the water quality and overall health of Wooster Lake. Granular 2,4-D was suggested for use as it should have minimal impacts on the whitestem pondweed.

The presence of EWM and another exotic, curlyleaf pondweed, are cause for concern. Curlyleaf pondweed was only found in 10% of plant samples, but EWM was the second most common plant in the lake. Control of these exotics is important for the future health of the lake. An aquatic management plan for the lake should incorporate all use aspects of the lake, including ecological and recreational functions. Ideally, some control of EWM and coontail can be incorporated while minimizing the impact to the beneficial native plants. Maintaining or even expanding the native plant communities will help control the spread of EWM. More information can be found in **Objective II: Aquatic Plant Management Options**.

In addition to the aquatic plant coverage in the lake, large portions of the plants that were at the surface were covered with filamentous algae. This created an aesthetically displeasing sight for lake residents as well as caused increased navigational problems near the shoreline. A plan to manage the algae problems on the lake can be incorporated into the overall aquatic plant management plan. More information can be found in **Objective III: Nuisance Algae Management Options**.

Floristic quality index (FQI; Swink and Wilhelm 1994) is an assessment tool designed to evaluate the closeness that the flora of an area is to that of undisturbed conditions. It can be used to: 1) identify natural areas, 2) compare the quality of different sites or different locations within a single site, 3) monitor long-term floristic trends, and 4) monitor habitat restoration efforts. Each aquatic plant in a lake is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). This is done for every floating and submersed plant species found in the lake. These numbers are averaged and multiplied by the square root of the number of species present to calculate an FQI. A high FQI number indicates that there are a large number of sensitive, high quality plant species present in the lake. Non-native species were counted in the FQI calculations for Lake County lakes. In 2003, Wooster Lake had a FQI of 25.7. For comparison, Fish Lake, Fischer Lake, and Duck Lake have FQIs of 18.1, 16.0, and 17.1, respectively. The median FQI of lakes that we have studied from 2000-2003 is 14.0.

Table 8. Aquatic and shoreline plants on Wooster Lake, May - September 2003.

<u>*Aquatic Plants*</u>	
Coontail	*Ceratophyllum demersum*
Chara	*Chara* sp.
American Elodea	*Elodea canadensis*
Small Duckweed	*Lemna minor*
Star Duckweed	*Lemna trisulca*
Northern Water Milfoil	*Myriophyllum sibiricum*
Eurasian Water Milfoil#	*Myriophyllum spicatum*
Slender Naiad	*Najas flexilis*
White Water Lily	*Nymphaea tuberosa*
Spatterdock	*Nuphar variegata*
Water Stargrass	*Heteranthera dubia*
Curlyleaf Pondweed#	*Potamogeton crispus*
Leafy Pondweed	*Potamogeton foliosus*
Whitestem Pondweed*	*Potamogeton praelongus*
Small Pondweed	*Potamogeton pusillus*
Flatstem Pondweed	*Potamogeton zosterifomis*
Sago Pondweed	*Stuckenia pectinatus*
Vallisneria (eel grass)	*Vallisneria americana*
Watermeal	*Wolffia columbiana*
<u>*Shoreline Plants*</u>	
Swamp Milkweed	*Asclepias incarnata*
Oxeye Daisy	*Chrysanthemum leucanthemum*
Black Walnut	*Juglans nigra*
Ash	*Fraxinus* sp.
Queen Anne's Lace#	*Daucus carota*
Purple Loosestrife#	*Lythrum salicaria*
White Sweet Clover#	*Melilotus alba*
Reed Canary Grass#	*Phalaris arundinacea*
Common Reed#	*Phragmites australis*
Buckthorn#	*Rhamnus cathartica*
Curled Dock#	*Rumex crispus*
Willow	*Salix* sp.
Chairmaker's Rush	*Scirpus pungens*
Hardstem Bulrush	*Scirpus acutus*
Softstem Bulrush	*Scirpus validus*
Sow Thistle#	*Sonchus* sp.
Cattail	*Typha* sp.

***Endangered in Illinois**
#Exotic species

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

A shoreline assessment was conducted in July 2003 to determine the condition of the lake shoreline (see Appendix B for methods). Of particular interest was the condition of the shoreline at the water/land interface.

Approximately 70% of the shoreline of Wooster Lake was classified as developed. Shrub habitat was the most common shoreline type comprising 22% of the shoreline (Figure 8). The next most common shoreline types were lawn (15%), wetland (15%), buffer (a strip of unmowed vegetation, preferably consisting of native plants;14%), and beach (12%). The remaining types (riprap, seawall, and woodland) each comprised less than 10% of the shoreline. Due to the poor root structure of turfgrass (lawn), it is recommended that these shoreline types be converted to buffer. Native plants, with deeper root structures, will stabilize the soil better and provide a filter mechanism for nutrients and pollutants that run off the surrounding landscape after rain events.

The shoreline was assessed for the degree and type of shoreline erosion (Figure 9). Approximately 31% or 2,994 feet of the shoreline was classified as slightly eroding and 4% or 411 feet was moderately eroding. No areas of the lake were classified as having severe erosion. The moderately eroded areas are along the northern portion of the lake were classified as lawn shoreline type. It is strongly recommended that the moderately eroded section be addressed immediately to prevent further degradation of the shoreline and the increase of sediment into Wooster Lake. For options on rehabilitating eroded shorelines, see **Objective IV: Shoreline Erosion Control**.

Several exotics were found growing along the shoreline, including buckthorn, reed canary grass, and common reed. Similar to aquatic exotics, these terrestrial exotics are detrimental to the native plant ecosystems around the lake. Removal or control of exotic species is recommended. For more information see **Objective V: Eliminate or Control Exotic Species**.

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

Good numbers of wildlife, particularly birds, were noted on and around Wooster Lake. See Appendix B for methods. Several of the species listed in Table 10 (below) were seen during spring or fall migration and were assumed not to be nesting around the lake.

Habitat around Wooster Lake was fair to good. The shrub and wetland habitat at the southern end of the lake provides good habitat for many species of fish and wildlife. Additional measures could be taken to improve habitat around the lake. For more information see **Objective VI: Enhance Wildlife Habitat Conditions**.

During the 2003 season, we observed large numbers of exotic mute swans (42 swans during one visit), resident Canada geese and mallard ducks. The waterfowl are primarily

Figure 8.

Figure 9.

the result of the long-term conservation efforts of one lake resident. While laudable, care should be exercised in maintaining such large numbers of waterfowl in a single location. Large concentrations of waterfowl that are together over an extended period of time may pose a threat to the health of the waterfowl and the overall health of the lake. Waterfowl under these conditions may be more susceptible to disease contraction and transmission. This may threaten both the exotic and semi-domesticated birds on the lake as well as wild populations of migrating waterfowl that use Wooster Lake as a stop-over location during spring and fall. In addition, waterfowl feces are high in nutrients, particularly nitrogen, phosphorus, and *E. coli* bacteria. The accumulation of these nutrients may exacerbate the water quality problems in the lake. For more information see **Objective VII: Canada Geese and Waterfowl**.

We did not conduct fish surveys in 2003. However, researchers from Southern Illinois University conducted a seining survey in June 2002, and found 15 species of fish, including two species listed as endangered in Illinois (Iowa darter, *Etheostoma exile*; blacknose shiner, *Notropis heterolepis*) and one species listed as threatened in Illinois (blackchin shiner, *Notropis heterodon*). Another species that is considered rare, the starhead topminnow (*Fundulus dispar*) was also found in the survey. A 1997 survey conducted by the Illinois Department of Natural Resources concluded that the bluegill and northern pike fisheries were in excellent shape, but largemouth bass abundance was low. Its recommendation was to establish a 15-inch length limit and one per day catch limit on largemouth bass and establish an aquatic plant management plan. The largemouth bass length limit was implemented shortly after this recommendation.

Table 10. Wildlife species observed on Wooster Lake, April – September 2003.

<u>Birds</u>	
Mute Swan	*Cygnus olor*
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhnchos*
Wood Duck	*Aix sponsa*
American Coot	*Fulica americana*
Ring-billed Gull	*Larus delawarensis*
Great Egret	*Casmerodius albus*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides striatus*
Killdeer	*Charadrius vociferus*
Spotted Sandpiper	*Actitis macularia*
Turkey Vulture	*Cathartes aura*
Mourning Dove	*Zenaida macroura*
Belted Kingfisher	*Megaceryle alcyon*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Common Flicker	*Colaptes auratus*
Downy Woodpecker	*Picoides pubescens*
Eastern Kingbird	*Tyrannus tyrannus*

Table 10. Wildlife species observed on Wooster Lake, April – September 2003 (cont'd).

Great Crested Flycatcher	*Myiarchus crinitus*
Willow Flycatcher	*Empidonax traillii*
Purple Martin	*Progne subis*
Barn Swallow	*Hirundo rustica*
Rough-wing Swallow	*Stelgidopteryx ruficollis*
Bank Swallow	*Riparia riparia*
American Crow	*Corvus brachyrhynchos*
Blue Jay	*Cyanocitta cristata*
House Wren	*Troglodytes aedon*
Catbird	*Dumetella carolinensis*
American Robin	*Turdus migratorius*
Wood Thrush	*Hylocichla mustelina*
Cedar Waxwing	*Bombycilla cedrorum*
Warbling Vireo	*Vireo gilvus*
Yellow Warbler	*Dendroica petechia*
Common Yellowthroat	*Geothlypis trichas*
Red-winged Blackbird	*Agelaius phoeniceus*
Common Grackle	*Quiscalus quiscula*
Starling	*Sturnus vulgaris*
Northern Oriole	*Icterus galbula*
House Sparrow	*Passer domesticus*
Northern Cardinal	*Cardinalis cardinalis*
American Goldfinch	*Carduelis tristis*
Mammals	
Eastern Chipmunk	*Tamias striatus*
Gray Squirrel	*Sciurus carolinensis*
Amphibians	
None noted.	
Reptiles	
Painted Turtle	*Chrysemys picta*
Insects	
Cicadas	Cicadidae
Dragonfly	Anisoptera
Damselfly	Zygoptera
Painted Lady Butterfly	*Vanessa cardui*
Tiger Swallowtail Butterfly	*Papilio glaucus*
Monarch Butterfly	*Danaus plexippus*

EXISTING LAKE QUALITY PROBLEMS

- *Lack of a Quality Bathymetric Map*

  A bathymetric (depth contour) map is an essential tool for effective lake management since it provides critical information on the morphometric features of the lake (i.e., acreage, depth, volume, etc.). This information is particularly important when intensive management techniques (i.e., chemical treatments for plant or algae control, dredging, fish stocking, etc.) are part of the lake's overall management plan. Currently only a 1971 bathymetric map exists. This map is outdated and lacks a morphometric table. We have recommended updating this map several times in the past.

- *Poor Lake Water Quality in Fish Lake Drain*

  Wooster Lake is the third of four lakes in the Fish Lake Drain watershed. Wooster Lake's water quality is significantly better than the other lakes in the watershed due primarily to its deeper depth, larger volume, and extensive aquatic plant populations. The upstream lakes, Fish Lake and Fischer Lake, have epilimnetic average total phosphorus concentrations three times and six times greater than the average in Wooster Lake, respectively. Inputs from these lakes and from stormwater runoff from Wooster Lake's immediate watershed are the greatest threats to the future water quality of the lake.

- *Need for an Aquatic Vegetation Management Plan*

  Wooster Lake supports a good diversity of aquatic plants, including whitestem pondweed, a state endangered species. However, the exotic Eurasian water milfoil and the native, but often invasive, coontail were dominant. Aquatic plants and algae, most of it concentrated along the shoreline, covered approximately 42% of the lake surface area. A management plan should include controlling some of the milfoil and coontail, but maintaining the species diversity in the lake. Overmanagement of the plants will have a negative impact on the lake's water quality. Beneficial native plants (both submersed and emergent) are present in the lake and should be encouraged to expand to enhance habitats for fish and wildlife, maintain good water quality, and help keep EWM and coontail densities under control.

- *Invasive Shoreline Plant Species*

  Numerous exotic plant species (i.e., buckthorn, reed canary grass, and common reed) were found on the shores of Wooster Lake. Buckthorn and reed canary grass are particularly problematic as they outcompete native plants and offer little value in terms of shoreline stabilization or wildlife habitat. These invasive plants should be removed and replaced with native shoreline plants.

- *Waterfowl*

  Large numbers of exotic mute swans, Canada geese, and mallard ducks were observed using the lake throughout the season. Concerns about the health of large numbers of waterfowl in one location for an extended period of time are coupled with the nutrient and bacteria inputs from the birds' feces, which may exacerbate the water quality issues in the lake.

POTENTIAL OBJECTIVES FOR THE WOOSTER LAKE MANAGEMENT PLAN

I. Bathymetric Map
II. Aquatic Plant Management Options
III. Nuisance Algae Management Options
IV. Shoreline Erosion Control
V. Eliminate or Control Exotic Species
VI. Enhance Wildlife Habitat Conditions
VII. Canada Geese and Waterfowl

OPTIONS FOR ACHIEVING THE LAKE MANAGEMENT PLAN OBJECTIVES

Objective I: Create a Bathymetric Map Including a Morphometric Table

A bathymetric map (depth contour) map is an essential tool for effective lake management since it provides critical information about the physical features of the lake, such as depth, surface area, volume, etc. This information is particularly important when intensive management techniques (i.e., chemical treatments for plant or algae control, dredging, fish stocking, etc.) are part of the lake's overall management plan. Some bathymetric maps for lakes in Lake County do exist, but they are frequently old, outdated and do not accurately represent the current features of the lake. Maps can be created by agencies like the Lake County Health Department - Lakes Management Unit or other companies. Costs vary, but can range from $3,000-10,000 depending on lake size. We have recommended updating this map several times in the past.

Objective II: Aquatic Plant Management Options

All aquatic plant management techniques have both positive and negative characteristics. If used properly, they can all be beneficial to a lake's well being. If misused or abused, they all share similar outcomes - negative impacts to the lake. Putting together a good aquatic plant management plan should not be rushed. Plans should consist of a realistic set of goals well thought out before implementation. The plan should be based on the management goals of the lake and involve usage issues, habitat maintenance/restoration, and limitations of the lake. For an aquatic plant management plan to achieve long term success, follow up is critical. A good aquatic plant management plan considers both the short and long-term needs of the lake. The management of the lake's vegetation does not end once the nuisance vegetation has been reduced/eliminated. It is critical to continually monitor problematic areas for regrowth and remove as necessary. An association or property owner should not always expect immediate results. A quick fix of the vegetation problems may not always be in the best interest of the lake. Sometimes the best solutions take several seasons to properly solve the problem. The management options covered below are commonly used techniques that are coming into wider acceptance and have been used in Lake County. There are other plant management options that are not covered below as they are not very effective, unreliable, or are too experimental to be widely used.

Option 1: No Action

If the lake is dominated by *native*, *non-invasive* species, the no action option could be ideal. Under these circumstances native plant populations could flourish and keep nuisance plants from becoming problematic. However, if a no action aquatic plant management plan in a lake with non-native, invasive species, nothing would be done to control the aquatic plant population of the lake regardless of the type and extent of the vegetation. Nuisance vegetation could continue to grow until epidemic proportions are reached. Growth limitations of the plant and the characteristics of the lake itself (light penetration, lake morphology, substrate type, etc.) will dictate the extent of infestation. Rooted plants, such as curly leaf pondweed (*Potamogeton crispus*) and elodea (*Elodea canadensis*), will be bound by physical factors such as substrate type and light availability. Plants such as Eurasian water milfoil and coontail, which can grow unrooted at the surface regardless of water depth, could grow to cover 100% of the water's surface. This could cause major inhibition of the lakes recreational uses and impact fish and other aquatic organisms adversely.

Pros

There are positive aspects associated with the no action option for plant management. The first, and most obvious, is that there is no cost. However, if an active management plan for vegetation control were eventually needed, the cost would be substantially higher than if the no action plan had not been followed in the first place. Another benefit of this option would be the lack of environmental manipulation. Under the no action option, no chemicals, mechanical alteration, or introduction of any organisms would take place. This is important since studies have shown that nuisance plants are more likely to invade disrupted areas. If the lake contains native, non-invasive plant species, expansion of the native plant population would increase the overall biodiversity and health of the lake. Habitat, breeding areas, and food source availability would greatly improve. Use of the lake would continue as normal and in some cases might improve (fishing) if native plants keep “weedy” plants under control.

An additional benefit of the no action option is the possible improvement in water quality. Turbidity could decrease and clarity should increase due to sediment stabilization by the plant’s roots. Algal blooms could be reduced due to decreased resource availability and sediment stabilization. However, the occurrence of filamentous algae may increase/remain stable due to their surface growth habitat. The lake’s fishery could improve due to habitat availability, which in turn would have numerous positive effects on the rest of the lake’s ecosystem.

Cons
Under the no action option, if nuisance vegetation is dominant in the lake and were uninhibited and able to reach epidemic proportions, there will be many negative impacts on the lake. By their weedy nature, the nuisance plants would out-compete the more desirable native plants. This could eventually, drastically reduce or even eliminate the native plant population of the lake and reduce the lake’s biodiversity. The fishery of the lake may become stunted due the to lack of quality forage fish habitat and reduced predation. Predation will decrease due to the difficulty of finding prey in the dense stands of vegetation. This will cause an explosion in the small fish population and with food resources not increasing, growth of fish will be reduced. Decreased dissolved oxygen levels, due to high biological oxygen demand from the excessive vegetation, will also have negative impacts on the aquatic life. Wildlife populations will also be negatively impacted by these dense stands of vegetation. Birds and waterfowl will have difficulty finding quality plants for food or in locating prey within the dense plant stands.

Water quality could also be negatively impacted with the implementation of the no action option. Deposition of large amounts of organic matter and release of nutrients upon the death of the massive stands of vegetation is a probable outcome of the no action option. These dead plants will contribute to the sediment load of the lake and could accelerate its filling in. The large nutrient release when the plants die back in the fall could lead to lake-wide algae blooms and an overall increase of the internal nutrient load. In addition, the decomposition of the massive amounts of vegetation will lead to a depletion of the lakes dissolved oxygen. This can cause fish stress, and eventually, if the stress is frequent or severe enough, fish kills. All of the impacts above could in turn have negative impacts on numerous aspects of the lake’s ecosystem.

In addition to the ecological impacts, many physical uses of the lake will be negatively impacted. Boating could be nearly impossible without becoming entangled in thick stands of plants. Swimming could also become increasingly difficult due to thick vegetation that would develop at beaches. Fishing could become more and more exasperating due in part to the thick vegetation and also because of the stunted fish population. In addition, the aesthetics of the lake will also decline due to large areas of the lake covered by tangled mats of vegetation and the odors that will develop when they decay. The combination of the above events could cause property values on the lake to suffer. Property values on lakes with weedy plant/algae problems have been shown to decrease by as much as 15-20%.

Costs
No cost will be incurred by implementing the no action management option. However, if in the future a management plan was initiated, costs might be significantly higher since a no action plan was originally followed.

Option 2: Aquatic Herbicides
Aquatic herbicides are the most common method to control nuisance vegetation/algae. When used properly, they can provide selective and reliable control. Products can not be licensed for use in aquatic situations unless there is less than a 1 in 1,000,000 chance of any negative effects on human health, wildlife, and the environment. Aquatic herbicides are not allowed to be environmentally persistent, bioaccumulate, or have any bioavailability. Prior to herbicide application, licensed applicators should evaluate the lake's vegetation and, along with the lake's management plan, choose the appropriate herbicide and treatment areas, and apply the herbicides during appropriate conditions (i.e., low wind speed, D.O. concentration, temperature).

There are two groups of herbicides: contact and systemic. Contact herbicides, like their name indicates, kill on contact. These herbicides affect only the above ground portion of the plant that they come into contact with and therefore do not kill the root system. An example of a contact herbicide is diquat. Systemic herbicides are taken up by the plant and disrupt cellular processes, which in turn cause plant death. These herbicides kill both the above ground portions of the plant as well as the root system. An example of a systemic herbicide is fluridone. Both types of herbicides are available in liquid or granular forms. Liquid forms are concentrated and need to be mixed into water to obtain the desired concentration. The solution is then sprayed on the water's surface or injected into the water in the treatment areas. Granular herbicides are broadcast in a known rate over the treatment area where they sink to the bottom. Some granular products slowly release the herbicide, which is then taken up by the plant. These are referred to as SRP formulations (Slow Release Pellet). Other granular herbicides come in crystal form and dissolve as they come in contact with water. This is typical of herbicides such as copper sulfate. Many herbicides come in both liquid and granular forms to fit the management needs of the lake. Herbicide applications can either be done as whole lake treatments or as more selective spot treatments. Multiple herbicides are often mixed and applied together. This is called a tank mix. This is done to save time, energy, and cost.

Aquatic herbicides are best used on actively growing plants to ensure optimal herbicide uptake. For this reason, herbicides are normally applied mid to late spring when water temperatures are above 60^{0}F. This is the time of year when the plants are most actively growing and before seed/vegetative propagule formation. Follow up applications should be done as needed. When choosing an aquatic herbicide it is important to know what plants are present, which ones are problematic, which plants are beneficial, and how a particular herbicide will act upon these plants. The herbicide label is very important and should always be read before use. There may be more than one herbicide for a given plant. As with other management options, proper usage is the key to their effectiveness, benefits, and disadvantages.

In Wooster Lake, an aquatic plant management plan should include an extensive assessment of the problem areas around the lake coupled with the goals and objectives of the uses of the lake by a variety of users (i.e., swimming, fishing, boating). With a large portion of the shallow areas (0-10 feet) covered with dense plant growth, an aquatic plant management plan may include limited herbicide treatments in areas that are most heavily used by recreational users. This may include boat lanes from the shoreline out to the deeper portions of the lake or around swimming areas or piers. If herbicides are used, care should be exercised as to not over treat an area. The target species should be identified and the appropriate herbicide used. In Wooster Lake, the target species are EWM and coontail. Using a 2,4-D herbicide would impact the EWM and coontail (which are dicots), but not necessarily the native pondweeds (which are monocots), including whitestem pondweed, which is an endangered species in Illinois. Spot treatments can be conducted in boating lanes and swimming areas as well. In all cases it is recommended that a licensed applicator should be hired to treat the lake. A whole-lake treatment is not recommended due to a number of factors. Whole-lake treatments with chemicals like fluridone may negatively impact the native plant populations, including the whitestem pondweed. In addition, fluridone is applied on a volume basis, and since Wooster Lake has only an old bathymetric map, an accurate assessment of volume cannot be made. Similarly a contact herbicide like diquat should not be used or only sparingly since it is non-selective and will kill all types of plants in a treatment area.

Pros

When used properly, aquatic herbicides can be a powerful tool in management of excessive vegetation. Often, aquatic herbicide treatments can be more cost effective in the long run compared to other management techniques. A properly implemented plan can often provide season long control with minimal applications. Ecologically, herbicides can be a better management option than using mechanical harvesting or grass carp. When properly applied, aquatic herbicides may be selective for nuisance plants such as Eurasian water milfoil but allow desirable plants such as American pondweed (*Potamogeton nodosus*) to remain. This removes the problematic vegetation and allows native and more desirable plants to remain and flourish with minimal manipulation.

The fisheries and waterfowl populations of the lake would benefit greatly due to an increase in quality habitat and food supply. Dense stands of plants would be thinned out and improve spawning habitat and food source availability for fish. Waterfowl population would greatly benefit from increases in quality food sources, such as large-leaf pondweed (*Potamogeton amplifolius*). Another environmental benefit of using aquatic herbicides over other management options is that they are organism specific. The metabolic pathways by which herbicides kill plants are plant specific, which humans and other organisms do not carry out. Organisms such as fish, birds, mussels, and zooplankton are generally unaffected.

By implementing a good management plan with aquatic herbicides, usage opportunities of the lake would increase. Activities such as boating and swimming would improve due to the removal of dense stands of vegetation. The quality of fishing may improve because of improved habitat. In addition to increased usage opportunities, the overall aesthetics of the lake would improve, potentially increasing property values on the lake.

Cons

The most obvious drawback of using aquatic herbicides is the input of chemicals into the lake. Even though the United States Environmental Protection Agency (USEPA) approved these chemicals for use, human error can make them unsafe and bring about undesired outcomes. If not properly used, aquatic herbicides can remove too much vegetation from the lake. This could drastically alter biodiversity and ecological. Total or over-removal of plants can cause a variety of problems lake-wide. The fishery of the lake may decline and/or become stunted due to predation issues related to decreased water clarity. Other wildlife, such as waterfowl, which commonly forage on aquatic plants, would also be negatively impacted by the decrease in food supply.

Another problem associated with removing too much vegetation is the loss of sediment stabilization by plants, which can lead to increased turbidity and resuspension of nutrients. The increase in turbidity can cause a decrease in light penetration, which can further aggravate the aquatic plant community. The resuspension of nutrients will contribute to the overall nutrient load of the lake, which can lead to an increased frequency of noxious algal blooms. Furthermore, the removal of aquatic vegetation, which competes with algae for resources, can directly contribute to an increase in blooms.

After the initial removal, there is a possibility for regrowth of vegetation. Upon regrowth, weedy plants such as Eurasian water milfoil and coontail quickly reestablish, form dense stands, and prevent the growth of desirable species. This causes a decrease in plant biodiveristy. Additionally, these dense stands of nuisance vegetation can lead to an overpopulation of stunted fish due to a decrease in predation of forage species by predatory fish. This disruption in the fisheries can have negative impacts throughout the ecosystem from zooplankton to higher organisms such as waterfowl and other wildlife. Additionally, some herbicides have use restrictions regarding their use in relation to fish, swimming, irrigation, etc.

Over-removal, and possible regrowth of nuisance vegetation that may follow will drastically impair recreational use of the lake. Swimming could be adversely affected due to the likelihood of increased algal blooms. Swimmers may become entangled in large mats of filamentous algae. Blooms of planktonic species, such as blue-green algae, can produce harmful toxins as well produce noxious odors. If regrowth of nuisance vegetation were to occur, motors could become entangled making boating difficult. Fishing would also be negatively impacted due to the decreased health of the lake's fishery. The overall appearance of the lake would also suffer due to an increase in unsightly algal blooms and massive stands of vegetation. This in turn could have an unwanted effect on property values. Studies have shown that problematic algal blooms can decrease property values by 15-20%.

Costs

To calculate total cost it will be necessary to calculate surface acreage (SA) or acre-feet (AF) of the area(s) to be treated according to each lake's aquatic plant management plan. The 2,4-D products (Aquacide®, Aqua-Kleen®, Navigate®, Weedar 64®) cost approximately $350-425 per surface acre. Based on the estimated 42% plant coverage on the lake, to treat 41.5 acres with 2,4-D would cost $14,525 - $17,638.

Option 3: Mechanical Harvesting

Mechanical harvesting involves the cutting and removal of nuisance aquatic vegetation by large specialized boats with underwater cutting bars. Plants are cut below the water at a level that will restore use of the lake. Typically, problematic areas are harvested and other areas are left alone. However, some management plans call for more widespread harvesting, especially when nuisance plants such as Eurasian water milfoil become dominant. The total removal or over removal (neither of which should never be the plan of any management entity) of plants by mechanical harvesting should never be attempted. To avoid complete or over removal, the management entity should have a harvesting plan that determines where and how much vegetation is to be removed.

In Wooster Lake, mechanical harvesting could be used to cut boating lanes from the shoreline out to deeper water and around shoreline area used for swimming. Harvesting would remove both aquatic plant and filamentous algae. A major challenge would be identifying a disposal site.

Pros

Mechanical harvesting can be a selective means to reduce stands of nuisance vegetation in a lake. Typically, plants cut low enough to restore recreational use and limit or prevent regrowth. This practice normally improves habitat for fish and other aquatic organisms. Some plant species such as curlyleaf pondweed, if harvested at the right time, do not grow back to nuisance proportions after harvesting. Plant clippings are high in nutrients and can be used as fertilizer or compost. Additionally, use of the lake is uninterrupted while harvesting is occurring.

By removing large quantities of plant biomass the overall quality of the lake may improve in many ways. The decrease in vegetative biomass will reduce the dissolved oxygen (D.O.) demand on the lake. This will cause increased dissolved oxygen levels. Some nuisance vegetation such as coontail have extremely high oxygen demands. Dense stands of these plants can quickly deplete a lake of D.O. during certain periods of the day. This can cause fish stress. Additionally, a decrease in plant density will improve the lake's fishery by creating better opportunities for predation, which is essential in creating a balanced fish population. By removing nuisance vegetation, recreational uses of the lake will improve. The quality of activities such as boating, swimming, and fishing would greatly improve. By removing dense stands of vegetation the possibility of entanglement will decrease thereby increasing opportunities for boating and swimming. Paths cut by the harvester will open fishing areas especially if networks of fish "cruising lanes" are created.

Cons

Once widespread, mechanical harvesting is becoming a less attractive management technique for a variety of reasons. Many applicators that regularly employed mechanical harvesting no longer use or even offer this service due to low public demand. In addition, high initial investment, extensive maintenance, and high operational costs have also led to decreased use. Since many applicators no longer offer harvesting services, a lake association would have to purchase and maintain their own harvester. Many associations do not even have the financial resources to cover the maintenance and operational cost involved with owning a harvester. Harvester costs can range from $50,000-$150,000. Beside the financial limitations there are also physical limitations. Mechanical harvesters cannot be used in less than 2-4 feet of water (depending on draft of the harvester) and can not maneuver well in tight places. The harvested plant material must be disposed of properly to a place that can accommodate large quantities of plants and prevent any from washing back into the lake. Fish, mussels, turtles and other aquatic organisms are commonly caught in the harvester and injured or even removed from the lake in the harvesting process.

After the initial removal, there is a possibility for vegetation regrowth. Upon regrowth, weedy plants such as Eurasian water milfoil and coontail quickly reestablish, form dense stands, and prevent the growth of desirable species. This causes a decrease in plant biodiveristy. Additionally, these dense stands of nuisance vegetation may lead to an overpopulation of stunted fish due to a decrease in predation of forage species by predatory fish. This disruption in the fishery will have negative impacts throughout the ecosystem from zooplankton to higher organisms such as waterfowl.

If complete/over removal does occur several problems can result. One problem is the loss of sediment stabilization by plants, which can lead to increased turbidity and resuspension of nutrients. The increase in turbidity can cause a decrease in light penetration, which can further aggravate the aquatic plant community. The resuspension of nutrients will also contribute to overall nutrient load of the lake, which can lead to increased frequency of algal blooms. Furthermore, the removal of aquatic vegetation, which competes with algae for resources with algae, can directly contribute to an increase in algal blooms. Removal of plants may lead to increased turbidity and decreased clarity. The fishery of the lake may decline and/or become stunted due changes in predation related to decreased water clarity. Other organisms, such as waterfowl, which commonly forage on native aquatic plants, would also be negatively impacted by the removal of these plants.

Another problem with mechanical harvesting, even if properly done, is that it can be a nonselective process. In the areas where harvesting is being conducted, one plant can not be removed and another left. All the plants are removed from that area. After the initial removal, regrowth of desirable plants does not typically occur in these harvested areas. Due to their weedy nature, plants such as Eurasian water milfoil, are able to grow more quickly than native plants and become more established in harvested areas. This will create a monoculture of nuisance vegetation. This causes an overall decrease in plant biodiversity, which can have detrimental effects to the entire ecosystem. Depending on the plant species, frequent harvesting might be required (typically 2-4 times per season). Along with this increased harvesting frequency come increased operational costs (labor, gas, maintenance, etc.). Nuisance plants such as coontail and Eurasian water milfoil can spread by vegetative fragments that may escape collection during the harvesting process and spread to uninfested parts of the lake. In addition to the release of plant fragments, as the plants are cut, there is a possibility of plant associated nutrients being released into the lake. This could cause an increase is algal blooms whenever harvesting in conducted. Short-term turbidity may also be created by the harvester paddle wheels stirring up sediment in harvested area.

Cost

Depending on the type of the harvester (cutting width, payload capacity, hull material, HP of the motor, trailer options, etc) prices range from $50,000 to $150,000. Operational and maintenance cost typically range from $161.00-$445.00/acre. Some companies, such as Aquarius Systems, sell used equipment at reduced prices.

Option 4: Hand Removal

Hand removal of excessive aquatic vegetation is a commonly used management technique. Hand removal is normally used in small ponds/lakes and limited areas for selective vegetation removal. Areas surrounding piers and beaches are commonly targeted areas. Typically tools such as rakes and cutting bars are used to remove vegetation. These are easily obtainable through many outdoor supply catalogs or over the internet. Some rakes are equipped with tines as well as cutting edges. Tools can also be hand made by drilling a hole in the handle of a heavy-duty garden rake and tying it to a length of rope. Weights may be needed in order to provide forceful contact with the plants. In many instances, homeowners on lakes with near shore vegetation problems simply cut swaths through the weeds to create pathways to open water. Due to the limited amount of biomass removed, harvested plant material is often used as fertilizer and compost in gardens.

This is a preferred option for removing nuisance aquatic plants and algae from small areas around Wooster Lake. At least one resident on the lake utilizes this technique with good success.

Pros

Hand removal is a quick, inexpensive, and selective way to remove nuisance vegetation. Hand removal is an activity in which all lake residents could participate. The work involved in removing plants can provide a rewarding sense of accomplishment. By removing excess vegetation, use of beaches and piers would be improved. Many of the improved water quality benefits of a well-executed herbicide program or harvesting program are also shared by hand removal. Wildlife habitat, such as fish spawning beds, could be greatly improved. This in turn would benefit other portions of the lake's ecosystem.

Cons

There are few negative attributes to hand removal. One negative implication is labor. Depending on the extent of infestation, removal of large amount, of vegetation can be quite tiresome. Another drawback can be disposal. Finding a site for numerous residents to dispose of large quantities of harvested vegetation can sometimes be problematic. However, individual homeowners would be removing limited quantities of plant material so there would not be much to dispose of. Another drawback is possible nonselective removal by hand harvesting. By throwing a rake blindly into the depths, it is impossible to determine what plants are removed and which ones are not until the rake is pulled up. Even in shallow depths, untrained persons might mistakenly remove desirable vegetation and/or disrupt valuable habitat (fish spawning beds). Over removal could also be a problem but is not normally a concern with hand removal.

Costs

Plant removal rakes can range in price from $50-150 and cutting tools commonly range in price from $50-200. Both are available from numerous catalogs and from the Internet. A homemade rake (heavy duty garden rake, rope, and weight) would cost about $20-40.

<u>Option 5: Water Milfoil Weevil</u>

Euhrychiopsis lecontei (*E. lecontei*) is a biological control organism used to control Eurasian water milfoil (EWM). *E. lecontei* is a native weevil, which feeds exclusively on milfoil species. It was originally discovered while investigating declines of EWM in a Vermont lake in the early 1990s. It was discovered in northeastern Illinois lakes by 1995. Another weevil, *Phytobius leucogaster*, also feeds on EWM but does not cause as much damage as *E. lecontei*. Therefore, *E. lecontei* is stocked as a biocontrol and is commonly referred to as the Eurasian water milfoil weevil. Currently, we have documented weevils (*E. lecontei* and/or *P. leucogaster*) in 32 Lake County lakes. Many of these lakes have seen declines in EWM densities in recent years. It is highly likely that *E. lecontei* and/or *P. leucogaster* occurs in all lakes in Lake County that have excessive EWM growth.

Weevils are stocked in known quantities to achieve a density of 1-4 weevils per stem. As weevil populations expand, EWM populations may decline. After EWM declines, weevil populations decline and do not feed on any other aquatic plants. When EWM starts to grow again in the spring, the weevil populations respond by keeping the increasing milfoil under control before it becomes a problem. Once the weevil is established, EWM should no longer reach nuisance proportions and begins to become more sparse. Best results are achieved in lakes that have shallow EWM infestations in areas where it is undisturbed by recreational and management actives. Weevils need proper overwintering habitat such as leaf litter and mud, which are typically found on naturalized shorelines or shores with good buffer strips. Additionally, water temperatures need to be 68-70°F for maximum weevil activity. For this reason, weevils are typically stocked in late spring/early summer. Currently only one company, EnviroScience Inc., has a stocking program (called the MiddFoil® process). The program includes evaluation of EWM densities, of current weevil populations (if any), stocking, monitoring, and restocking as needed.

While weevils were not found in Wooster Lake in 2003, it is possible that they could be in the lake and not in sufficient numbers to be detected by our surveys. Fischer Lake, which drains into Wooster Lake, did have weevils in a survey that we did on that lake in 2001.

Pros

The milfoil weevil can provide long-term control of EWM. Typically, by the end of June EWM stands are starting to decline due to weevil damage. In many situations, EWM beds might not reach the surface before weevil damage causes declines. *E. lecontei* is also a selective means to control EWM. Studies have shown that *E. lecontei* has a strong preference for EWM and the only other plant it possibly will feed on is northern water milfoil. Since milfoil weevils are found to naturally occur in several lakes in Lake County, weevil stocking would be an augmentation rather than an introduction, making it a more natural control option.

If control with milfoil weevils were successful, the quality of the lake would be improved. Native plants could then start to recolonize. Fisheries of the lake would improve due to more balanced predation and higher quality habitat. Waterfowl would benefit due to increased food sources and availability of prey. Recreational activities such as fishing, swimming, and boating would be easier and more enjoyable with the removal of inhibiting stands of EWM.

Cons

Use of milfoil weevils does have some drawbacks. Control using the weevil has been inconsistent in many cases. EWM has been reduced one year, only to be unaffected the next. Reasons for these inconsistencies are under investigation. One possible explanation is lack of suitable overwintering habitat. The highly developed, manicured shorelines of many lakes in the County are not suitable habitat for weevil overwintering. Another possible explanation is cooler than normal summer water temperatures. Studies have shown that cooler water temperatures reduce weevil feeding and egg production.

Milfoil control using weevils may not work well on plants in deep water. Plants are able to compensate for weevil damage on upper portions of the plant by increasing growth on lower portions where weevil does not feed. Furthermore, weevils do not work well in areas where plants are continuously disturbed by activities such as powerboats and swimming, harvesting or herbicide use. In areas where weevils are to be stocked, activity should be reduced as much as possible. This may either limit the extent to which the weevils can be used or limit recreational use of the lake.

One of the most prohibitive aspects to weevil use is price. Typically weevils are stocked to achieve a density of 1-4 weevils per stem. This translates to 500-3000 weevils per acre. At a cost of $1 per weevil plus labor, a EWM management program using weevils can be expensive. Additionally, there is no guarantee that weevils will provide long term control or even produce any results at all.

Costs
EnviroScience, Inc.
3781 Darrow Road
Stow, Ohio 44224
1(800) 940-4025

Weevils are sold in units of 1000 bugs/unit and stocking rates must be at least 1 unit/stocked area. Normally there is a minimum purchase of 5-10 units. The cost of the weevils does not include the labor involved in initial surveys, stocking, and monitoring, which typically run an additionally $3,500-$4,500.

Option 6: Reestablishing Native Aquatic Vegetation

Revegetation should only be done when existing nuisance vegetation, such as Eurasian water milfoil, are under control using one of the above management options. If the lake has poor clarity due to excessive algal growth or turbidity, these problems must be addressed before a revegetation plan is undertaken. Without adequate light penetration, revegetation will not work. At maximum, planting depth light levels must be greater than 1-5% of the surface light levels for plant growth and photosynthesis.

There are two methods by which reestablishment can be accomplished. The first is use of existing plant populations to revegetate other areas within the lake. Plants from one part of the lake are allowed to naturally expand into adjacent areas thereby filling the niche left by the nuisance plants. Another technique utilizing existing plants is to transplant vegetation from one area to another. The second method of reestablishment is to import native plants from an outside source. A variety of plants can be ordered from nurseries that specialize in native aquatic plants. These plants are available in several forms such as seeds, roots, and small plants. These two methods can be used in conjunction with one another in order to increase both quantity and biodiversity of plant populations. Additionally, plantings must be protected from herbivory by waterfowl and other wildlife. Simple cages made out of wooden or metal stakes and chicken wire are erected around planted areas for at least one season. The cages are removed once the plants are established and less vulnerable. If large-scale revegetation is needed it would be best to use a consultant to plan and conduct the restoration. Table 11 lists common, native plants that should be considered when developing a revegetation plan. Included in this list are emergent shoreline vegetation (rushes, cattails, etc) and submersed aquatic plants (pondweeds, *Vallisneria*, etc). Prices, planting depths, and planting densities are included and vary depending on plant species.

Pros

By revegetating newly opened areas that were once infested with nuisance species, the lake will benefit in several ways. Once established, expanded native plant populations will help to control growth of nuisance vegetation. This provides a more natural approach as compared to other management options. In addition, using established native plants to control excessive invasive plant growth can be less expensive in the long run than other options. Expanded native plant populations will also help with sediment stabilization. This in turn will have a positive effect on water clarity by reducing suspended solids and nutrients that decrease clarity and cause excessive algal growth. Properly revegetating shallow water areas with plants such as cattails, bulrushes, and water lilies can help reduce wave action that can lead to shoreline erosion. Increases in desirable vegetation will increase the plant biodiversity and also provide better quality habitat and food sources for fish and other wildlife. Recreational uses of the lake such as fishing and boating will also increase due to the improvement in water quality and the suppression of weedy species.

Cons

There are few negative impacts to revegetating a lake. One possible drawback is the possibility of new vegetation expanding to nuisance levels and needing control. However, this is an unlikely outcome. Another drawback could be high costs if extensive revegetation is needed using imported plants. If a consultant is used costs would be substantially higher. Additional costs could be associated with constructing proper herbivory protection measures.

Costs

See Table 11 for plant pricing. Costs will be higher if a consultant/nursery is contracted for design and labor. Additional costs will include herbivory protection materials such as metal posts and protective wire mesh (chicken wire).

Objective III: Nuisance Algae Management Options

The growth of nuisance or excessive algae can cause a number of problems. Excessive algal growth can cause decreases in water clarity and light penetration. This can lead to several major problems such as loss of aquatic plants, decline in fishery health, and interference with recreational activities. Health hazards, such as swimmer's itch and other skin irritations have been linked to nuisance algae growth. Normally, excessive/nuisance algae growth is a sign of larger problems such excessive nutrients and/or lack of aquatic plants. Some treatment methods, such as copper sulfate, are only quick remedies to the problem. Solving the problem of nuisance algal growth involves treating the factors that cause the growth not the algae itself. Long-term solutions typically include an integrated approach such as alum treatments, revegetation with aquatic plants, and limiting external sources of nutrients. Interestingly enough, these long-term management strategies are seldom used, typically because of their high initial costs. Instead, the cheap, quick fix of using copper sulfate, though temporary, is much more widely used. However, the costs of continually applying copper sulfate over years, even decades, can eventually far exceed the costs of a slower acting, eventually more effective, integrated approach.

As with aquatic plant management techniques, algae management practices have both positive and negative characteristics. If used properly, they can be beneficial to a lake's well being. If misused or abused, they all share similar outcomes - negative impacts to the lake. Putting together a good management plan should not be rushed. Plans should consist of a realistic set of goals well thought out before implementation. The plan should be based on the management goals of the lake and involve usage issues (beaches, boat ramps, etc.), habitat maintenance/restoration issues, and nutrient levels. For an algal management plan to achieve long term success, follow up is critical. The management of the lake's algae problem does not end once the blooms and/or mats have been reduced/eliminated. It is critical to continually monitor problematic areas for regrowth and treat as necessary. An association or property owner should not always expect immediate results. A quick fix of the algal problem may not always be in the best interest of the lake. Sometimes the best solutions take several seasons to properly address the problem. The management options covered below are commonly used techniques and those that are coming into wider acceptance, and have been used in Lake County. There are other algae management options that are not covered below as they are not very effective, unproven, unfounded, or are too experimental to be widely used.

Option 1: No Action

With a no action management plan nothing would be done to control the nuisance algae regardless of type and extent. Nuisance algae, planktonic and/or filamentous, could continue to grow until epidemic proportions are reached. Growth limitations of the algae and the characteristics of the lake itself (light penetration, nutrient levels.) will dictate the extent of growth. Unlike aquatic plants, algae are not normally bound by physical factors such as substrate type. The areas in which filamentous and thick surface planktonic blooms (scum) occur can be affected by wind and wave action if strong enough. However, under normal conditions, with no action, both filamentous and planktonic algal blooms can spread to cover 100% of the surface. This could cause major inhibition of the lakes recreational uses and impact fish and other aquatic organisms adversely.

Pros

There are positive aspects associated with the no action option for nuisance algae management. The first, and most obvious, is that there is no cost. However, if an active management plan for algae control were eventually needed, the cost would be substantially higher than if the no action plan had been followed in the first place. Another benefit of this option would be the lack of environmental manipulation. Under the no action option, chemicals or introduction of any organisms would not take place. Use of the lake would continue as normal unless blooms worsened. In this case, activities such as swimming might have to be suspended due to an increase in health risks. Other problems such as strong odors (blue-green algae) might also increase in frequency.

Cons

Under the no action option, if nuisance algae becomes wide spread and able to reach epidemic proportions, there will be many negative impacts on the lake. The fishery of the lake may become stunted due the to lack of quality forage fish habitat and reduced predation. This will cause an explosion in the small fish population and with food resources not increasing, growth of fish will be reduced. Fish kills can result from toxins released by some species such as some blue-green algae. Blue-green algae can also produced toxins that are harmful to other algae. This allows blue-green algae to quickly dominate a body of water. Decreased dissolved oxygen levels, due to high biological oxygen demand from the excessive algae growth, will also have negative impacts on the aquatic life. Wildlife populations will also be negatively impacted by dense growths of algae. Birds and waterfowl will have difficulty finding quality plants for food or in locating prey within the turbid green waters. Additionally, some species, such as blue-green algae, are poor sources of food for zooplankton and fish.

Water quality could also be negatively impacted with the implementation of a no action option. Decomposition of organic matter and release of nutrients upon algal death is a probable outcome. Large nutrient release with algae die back could lead to lake-wide increases of internal nutrient load. This could in turn, could increase the frequency or severity of other blooms. In addition, decomposition of massive amounts of algae, filamentous and planktonic, will lead to a depletion of dissolved oxygen in the lake. This can cause fish stress, and eventually, if stress is frequent or severe enough, fish kills. All of the impacts above could in turn have negative impacts on numerous aspects of the lake's ecosystem.

In addition to ecological impacts, many physical lake uses will be negatively impacted. Boating could be nearly impossible without becoming entangled in thick mats of filamentous algae. Swimming could also become increasingly difficult and unsafe due to thick mats and reduction in visibility by planktonic blooms. Fishing could become more and more exasperating due in part to the thick mats and stunted fish populations. In addition, the aesthetics of the lake will also decline due to large areas of the lake covered by large green mats and/or blooms of algae and the odors that may develop, such as with large blue-green blooms. The combination of above events could cause property values on the lake to suffer. Property values on lakes with algae problems have been shown to decrease by as much as 15-20%.

Costs

No cost will be incurred by implementing the no action management option.

Option 2: Algicides

Algicides are a quick and inexpensive way to temporarily treat nuisance algae. Copper sulfate ($CuSO_4$) and chelated copper products are the two main algicides in use. These two compounds are sold by a variety of brand names by a number of different companies. There is also a non-copper based algaecide on the market called GreenClean™ from BIOsafe Systems, which contains the active ingredient sodium carbonate peroxyhydrate. Regardless of active ingredient, they all work the same and act as contact killers. This means that the product has to come into contact with the algae to be affective. Algicides come in two forms, granular and liquid. Granular herbicides are spread by hand or machine over an effected area. They can also be placed in a porous bag (such as a burlap sack) and dragged though the water in order to dissolve and disperse the product. Granular algicides are mainly used on filamentous algae where they are spread over the mats. As the granules dissolve, they kill the algae. Liquid algicides, which are much more widely used, are mixed with a known amount of water to achieve a known concentration. The mixture is then sprayed onto/into the water. Liquid algicides are used on both filamentous and planktonic algae. Liquid algaecides are often mixed with herbicides and applied together to save on time and money. The effectiveness of some herbicides is enhanced when mixed with an algicide. When applying an algicide it is imperative that the label is completely read and followed. If too much of the lake is treated at any one time an oxygen crash may occur. This may cause fish kills due to decomposition of treated algae. Additionally, treatments should never be made when blooms/mats are at their fullest extent. It is best to divide the lake into at least two sections depending on the size of the lake. Larger lakes will need to be divided into more sections. Then treat the lake one section at a time allowing at least two weeks between treatments. Furthermore, application of algicides should never be done in extremely hot weather (>90^{o}F) or when D.O. concentrations are low. This will help lessen the likelihood of an oxygen crash and resulting fish kills. When possible, treatments should be made as early in the season as possible when temperature and D.O. concentrations are adequate. It is best to treat in spring or when the blooms/mats starts to appear there by killing the algae before they become a problem.

Pros

When used properly, algicides can be a powerful tool in management of nuisance algae growth. A properly implemented plan can often provide season long control with minimal applications. Another benefit of using algicides is their low costs. The fisheries and waterfowl populations of the lake would greatly benefit due to a decrease in nuisance algal blooms. By reducing the algae, clarity would increase. This in turn would allow the native aquatic plants to return to the lake. Newly established stands of plants would improve spawning habitat and food source availability for fish. Waterfowl population would greatly benefit from increases in quality food sources, such as large-leaf pondweed (*Potamogeton amplifolius*) and sago pondweed (*Potamogeton pectinatus*). Additionally, copper products, at proper dosages, are selective in the sense that they do not affect aquatic vascular plants and wildlife.

By implementing a good management plan, usage opportunities for the lake would increase. Activities such as boating and swimming would improve due to the removal of thick blooms and/or mats of algae. Health risks associated with excessive algae growth (toxins, reduced visibility, etc.) The quality of fishing may recover due to improved habitat and feeding opportunities. In addition to increased usage opportunities, overall aesthetics of the lake would improve, potentially increasing property values.

Cons

The most obvious drawback of using algicides is the input of chemicals into the lake. Even though the United States Environmental Protection Agency (USEPA) approved these chemicals for use, human error and overuse can make them unsafe and bring about undesired outcomes. By continually killing particular algal species, lake managers may unknowingly be creating a larger problem. As the algae are continuously exposed to copper, some species are becoming more and more tolerant. This results in the use of higher concentrations in order to achieve adequate control, which can be unhealthy for the lake. In other instances, by eliminating one type of algae, lake managers are finding that other species that are even more problematic are filling the empty gap. These species that fill the gap can often be more difficult to control due to an inherent resistance to copper products. Additionally, excessive use of copper products can lead to a build up of copper in lake sediment. This can cause problems for activities such as dredging. Due to a large amount of copper in the sediment, special permits and disposal methods would have to be utilized.

Costs

To calculate total cost it will be necessary to calculate surface acreage (SA) or acre-feet (AF) of the area(s) to be treated according to each lake's aquatic plant management plan. The chelated copper products (Clearigate®, Cutrine®, Captain®, K-Tea®, Komeen®) cost $35-45 per gallon and are generally applied at 0.5-2.5 gallons per acre-foot depending on the product.

Option 3: Alum Treatment

A possible remedy to excessive algal growth is to eliminate or greatly reduce the amount of phosphorus. This can be accomplished by using aluminum sulfate (alum). Alum does not directly kill algae as copper sulfate does. Instead, alum binds phosphorus making it unavailable, thus reducing algal growth. Alum binds water-borne phosphorus and forms a flocculent layer that settles on the bottom. This floc layer can then prevent sediment bound phosphorus from entering the water column. Phosphorus inactivation using alum has been in use for 25 years. However, cost and sometimes unreliable results deterred its wide spread use. Currently, alum is commonly being used in ponds and small lakes, and its use in larger lakes is increasing. Alum treatment typically lasts 1 to 20 years depending on various parameters. Lakes with low mean depth to surface area ratio benefit more quickly from alum applications, while lakes with high mean depth to surface area ration (thermally stratified lakes) will see more longevity from an alum application due to isolation of the flocculent layer. Lakes with small watersheds are also better candidates because external phosphorus sources can be limited. Alum treatments must be carefully planned and carried out by an experienced professional. If not properly done, there may be many detrimental side effects.

Pros

Phosphorus inactivation is a possible long-term solution for controlling nuisance algae and increasing water clarity. Alum treatments can last as long as 20 years. This makes alum more cost effective in the long-term compared to continual treatment with algaecides. Studies have shown reductions in phosphorus concentrations by 66% in spring and 68% in summer. Chlorophyll *a*, a measure of algal biomass, was reduced by 61%. Reduction in algal biomass caused an increase in dissolved oxygen and a 79% increase in Secchi disk readings. Effects of alum treatments can be seen in as little as a few days. The increase in clarity can have many positive effects on the lake's ecosystem. With increased clarity, plant populations could expand or reestablish. This in turn would improve fish habitat and provide improved food/habitat sources for other organisms. Recreational activities such as swimming and fishing would be improved due to increased water clarity and healthy plant populations. Typically, there is a slight invertebrate decline immediately following treatment but populations recover fully by the following year.

Cons

There are several drawbacks to alum. External nutrient inputs must also be reduced or eliminated for alum to provide long-term effectiveness. With larger watersheds this could prove to be physically and financially impossible. Phosphorus inactivation may be shortened by excessive plant growth or motorboat traffic, which can disturb the flocculent layer and allow phosphorus to be released. Also, lakes that are shallow, non-stratified, and wind blown typically do not achieve long-term control due to disruption of the flocculent layer. If alum is not properly applied toxicity problems may occur. Typically aluminum toxicity occurs if pH is below 6 or above 9. Most of Lake County's lakes are in this safe range. However, at these pHs, special precautions must be taken when applying alum. By adding the incorrect amounts of alum, pH of the lake could drastically change. Due to these dangers, it is highly recommended that a lake management professional plans and administers the alum treatment.

Costs
Morphometric data is required to make proper calculations. Currently, only an old 1971 bathymetric map with no morphometric data of Wooster Lake exists.

Option 4: Revegetation With Native Aquatic Plants
This option is identical to Option 6 in **Objective I. Aquatic Plant Management Options.**

Objective IV: Shoreline Erosion Control

Erosion is a potentially serious problem to lake shorelines and occurs as a result of wind, wave, or ice action or from overland rainwater runoff. While some erosion to shorelines is natural, human alteration of the environment can accelerate and exacerbate the problem. Erosion not only results in loss of shoreline, but negatively influences the lake's overall water quality by contributing nutrients, sediment, and pollutants into the water. This effect is felt throughout the food chain since poor water quality negatively affects everything from microbial life to sight feeding fish and birds to people who want to use the lake for recreational purposes. The resulting increased amount of sediment will over time begin to fill in the lake, decreasing overall lake depth and volume and potentially impairing various recreational uses.

Option 1: No Action

Pros

There are no short-term costs to this option. However, extended periods of erosion may result in substantially higher costs to repair the shoreline in the future.

Eroding banks on steep slopes can provide habitat for wildlife, particularly bird species (e.g., kingfishers and bank swallows) that need to burrow into exposed banks to nest. In addition, certain minerals and salts in the soils are exposed during the erosion process, which are utilized by various wildlife species.

Cons

Taking no action will most likely cause erosion to continue and subsequently may cause poor water quality due to high levels of sediment or nutrients entering a lake. This in turn may retard plant growth and provide additional nutrients for algal growth. A continual loss of shoreline is both aesthetically unpleasing and may potentially reduce property values. Since a shoreline is easier to protect than it is to rehabilitate, it is in the interest of the property owner to address the erosion issue immediately.

Costs

In the short-term, cost of this option is zero. However, long-term implications can be severe since prolonged erosion problems may be more costly to repair than if the problems were addressed earlier. As mentioned previously, long-term erosion may cause serious damage to shoreline property and in some cases lower property values.

Option 2: Install a Seawall

Seawalls are designed to prevent shoreline erosion on lakes in a similar manner they are used along coastlines to prevent beach erosion or harbor siltation. Today, seawalls are generally constructed of steel, although in the past seawalls were made of concrete or wood (frequently old railroad ties). Concrete seawalls cracked or were undercut by wave action requiring routine maintenance. Wooden seawalls made of old railroad ties are not used anymore since the chemicals that made the ties rot-resistant could be harmful to aquatic organisms. A new type of construction material being used is vinyl or PVC. Vinyl seawalls are constructed of a lighter, more flexible material as compared to steel. Also, vinyl seawalls will not rust over time as steel will.

Pros

If installed properly and in the appropriate areas (i.e., shorelines with severe erosion) seawalls provide effective erosion control. Seawalls are made to last numerous years and have relatively low maintenance.

Cons

Seawalls are disadvantageous for several reasons. One of the main disadvantages is that they are expensive, since a professional contractor and heavy equipment are needed for installation. Any repair costs tend to be expensive as well. If any fill material is placed in the floodplain along the shoreline, compensatory storage may also be needed. Compensatory storage is the process of excavating in a portion of a property or floodplain to compensate for the filling in of another portion of the floodplain. Permits and surveys are needed whether replacing and old seawall or installing a new one (see costs below).

Wave deflection is another disadvantage to seawalls. Wave energy not absorbed by the shoreline is deflected back into the lake, potentially causing sediment disturbance and resuspension, which in turn may cause poor water clarity and problems with nuisance algae, which use the resuspended nutrients for growth. If seawalls are installed in areas near channels, velocity of run-off water or channel flow may be accelerated. This may lead to flooding during times of high rainfall and run-off, shoreline erosion in other areas of the lake, or a resuspension of sediment due to the agitation of the increased wave action or channel flow, all of which may contribute to poor water quality conditions throughout the lake. Plant growth may be limited due to poor water clarity, since the photosynthetic zone where light can penetrate, and thus utilized by plants, is reduced. Healthy plants are important to the lake's overall water clarity since they can help filter some of the incoming sediment, prevent resuspension of bottom sediment, and compete with algae for nutrients. However, excessive sediment in the water and high turbidity may overwhelm these benefits.

Finally, seawalls provide no habitat for fish or wildlife. Because there is no structure for fish, wildlife, or their prey, few animals use shorelines with seawalls. In addition, poor water clarity that may be caused by resuspension of sediment from deflected wave action contributes to poor fish and wildlife habitat, since sight feeding fish and birds (i.e., bass, herons, and kingfishers) are less successful at catching prey. This may contribute to a lake's poor fishery (i.e., stunted fish populations).

Costs

Depending on factors such as slope and shoreline access, cost of seawall installation ranges from $85-100 per linear foot for steel and $95-110 per linear foot for vinyl. A licensed contractor installs both types of seawall. Additional costs may occur if the shoreline needs to be graded and backfilled, has a steep slope, or poor accessibility. Price does not include the necessary permits required. Additional costs will be incurred if compensatory storage is needed. Prior to the initiation of work, permits and/or surveys from the appropriate government agencies need to be obtained. For seawalls, a site development permit and a building permit are needed. Costs for permits and surveys can be $1,500-2,000 for installation of a seawall. Contact the Army Corps of Engineers, local municipality, or the Lake County Planning and Development Department.

Around Wooster Lake, the costs to install a seawall along the moderately eroded shoreline (411 feet) would cost approximately $34,935 – 41,100 for steel and $39,045 – 45,210 for vinyl.

Option 3: Install Rock Rip-Rap or Gabions

Rip-rap is the term for using rocks to stabilize shorelines. Size of the rock depends on the severity of the erosion, distance to rock source, and aesthetic preferences. Generally, four to eight inch diameter rocks are used. Gabions are wire cages or baskets filled with rock. They provide similar protection as rip-rap, but are less prone to displacement. They can be stacked, like blocks, to provide erosion control for extremely steep slopes. Both rip-rap and gabions can be incorporated with other erosion control techniques such as plant buffer strips. If any plants will be growing on top of the rip-rap or gabions, fill will probably be needed to cover the rocks and provide an acceptable medium for plants to grow on. Prior to the initiation of work, permits and/or surveys from the appropriate government agencies need to be obtained (see costs below).

Pros

Rip-rap and gabions can provide good shoreline erosion control. Rocks can absorb some of the wave energy while providing a more aesthetically pleasing appearance than seawalls. If installed properly, rip-rap and gabions will last for many years. Maintenance is relatively low, however, undercutting of the bank can cause sloughing of the rip-rap and subsequent shoreline. Areas with severe erosion problems may benefit from using rip-rap or gabions. In all cases, a filter fabric should be installed under the rocks to maximize its effectiveness.

Fish and wildlife habitat can be provided if large boulders are used. Crevices and spaces between the rocks can be used by a variety of animals and their prey. Small mammals, like shrews can inhabit these spaces in the rock above water and prey upon many invertebrate species, including many harmful garden and lawn pests. Also, small fish may utilize the structure underwater created by large boulders for foraging and hiding from predators.

Cons
A major disadvantage of rip-rap is the initial expense of installation and associated permits. Installation is expensive since a licensed contractor and heavy equipment are generally needed to conduct the work. Permits are required if replacing existing or installing new rip-rap or gabions and must be acquired prior to work beginning. If any fill material is placed in the floodplain along the shoreline, compensatory storage may also be needed. Compensatory storage is the process of excavating in a portion of a property or floodplain to compensate for the filling in of another portion of the floodplain.

While rip-rap and gabions absorb wave energy more effectively than seawalls, there is still some wave deflection that may cause resuspension of sediment and nutrients into the water column.

Small rock rip-rap is poor habitat for many fish and wildlife species, since it provides limited structure for fish and cover for wildlife. As noted earlier, some small fish and other animals will inhabit the rocks if boulders are used. Smaller rip-rap is more likely to wash away due to rising water levels or wave action. On the other hand, larger boulders are more expensive to haul in and install.

Rip-rap may be a concern in areas of high public usage since it is difficult and possibly dangerous to walk on due to the jagged and uneven rock edges. This may be a liability concern to property owners.

Costs
Cost and type of rip-rap used depend on several factors, but average cost for installation (rocks and filter fabric) is approximately $35-50 per linear foot. Costs for gabions are approximately $70-100 per linear foot when filled with rocks. The steeper the slope and severity of erosion, the larger the boulders that will need to be used and thus, higher installation costs. In addition, costs will increase with poor shoreline accessibility and increased distance to rock source. Costs for permits and surveys can be $1,500-2,000 for installation of rip-rap or gabions, depending on the circumstances. Additional costs will be incurred if compensatory storage is needed. Contact the Army Corps of Engineers, local municipalities, and the Lake County Planning and Development Department.

Around Wooster Lake, the costs to install riprap along the moderately eroded shoreline (411 feet) would cost approximately $14,385 – 20,550.

Option 4: Create a Buffer Strip
Another effective method of controlling shoreline erosion is to create a buffer strip with existing or native vegetation. Native plants have deeper root systems than turfgrass and thus hold soil more effectively. Native plants also provide positive aesthetics and good wildlife habitat. Cost of creating a buffer strip is quite variable, depending on the current state of the vegetation and shoreline and whether vegetation is allowed to become

established naturally or if the area needs to be graded and replanted. Allowing vegetation to naturally propagate the shoreline would be the most cost effective, depending on the severity of erosion and the composition of the current vegetation. Non-native plants or noxious weedy species may be present and should be controlled or eliminated.

Stabilizing the shoreline with vegetation is most effective on slopes no less than 2:1 to 3:1, horizontal to vertical, or flatter. Usually a buffer strip of at least 25 feet is recommended, however, wider strips (50 or even 100 feet) are recommended on steeper slopes or areas with severe erosion problems. Areas where erosion is severe or where slopes are greater than 3:1, additional erosion control techniques may have to be incorporated such as biologs, A-Jacks®, or rip-rap.

Buffer strips can be constructed in a variety of ways with various plant species. Generally, buffer strip vegetation consists of native terrestrial (land) species and emergent (at the land and water interface) species. Terrestrial vegetation such as native grasses and wildflowers can be used to create a buffer strip along lake shorelines. A table in Appendix A gives some examples, seeding rates and costs of grasses and seed mixes that can be used to create buffer strips. Native plants and seeds can be purchased at regional nurseries or from catalogs. When purchasing seed mixes, care should be taken that native plant seeds are used. Some commercial seed mixes contain non-native or weedy species or may contain annual wildflowers that will have to be reseeded every year. If purchasing plants from a nursery or if a licensed contractor is installing plants, inquire about any guarantees they may have on plant survival. Finally, new plants should be protected from herbivory (e.g., geese and muskrats) by placing a wire cage over the plants for at least one year.

A technique that is sometimes implemented along shorelines is the use of willow posts, or live stakes, which are harvested cuttings from live willows (*Salix* spp.). They can be planted along the shoreline along with a cover crop or native seed mix. The willows will resprout and begin establishing a deep root structure that secures the soil. If the shoreline is highly erodible, willow posts may have to be used in conjunction with another erosion control technique such as biologs, A-Jacks ®, or rip-rap.

Emergent vegetation, or those plants that grow in shallow water and wet areas, can be used to control erosion more naturally than seawalls or rip-rap. Native emergent vegetation can be either hand planted or allowed to become established on its own over time. Some plants, such as native cattails (*Typha* sp.), quickly spread and help stabilize shorelines, however they can be aggressive and may pose a problem later. Other species, such as those listed in a table in Appendix A should be considered for native plantings.

Pros

Buffer strips can be one of the least expensive means to stabilize shorelines. If no permits or heavy equipment are needed (i.e., no significant earthmoving or filling is planned), the property owner can complete the work without the need of professional contractors. Once established (typically within 3 years), a buffer strip of native vegetation will require little maintenance and may actually reduce the overall maintenance of the property, since the buffer strip will not have to be continuously mowed, watered, or fertilized. Occasional high mowing (1-2 times per year) for specific plants or physically removing other weedy species may be needed.

The buffer strip will stabilize the soil with its deep root structure and help filter run-off from lawns and agricultural fields by trapping nutrients, pollutants, and sediment that would otherwise drain into the lake. This may have a positive impact on the lake's water quality since there will be less "food" for nuisance algae. Buffer strips can filter as much as 70-95% of sediment and 25-60% of nutrients and other pollutants from runoff.

Another benefit of a buffer strip is potential flood control protection. Buffer strips may slow the velocity of flood waters, thus preventing shoreline erosion. Native plants also can withstand fluctuating water levels more effectively than commercial turfgrass. Many plants can survive after being under water for several days, even weeks, while turfgrass is intolerant of wet conditions and usually dies after several days under water. This contributes to increased maintenance costs, since the turfgrass has to be either replanted or replaced with sod. Emergent vegetation can provide additional help in preserving shorelines and improving water quality by absorbing wave energy that might otherwise batter the shoreline. Calmer wave action will result in less shoreline erosion and resuspension of bottom sediment, which may result in potential improvements in water quality.

Many fish and wildlife species prefer the native shoreline vegetation habitat. This habitat is an asset to the lake's fishery since the emergent vegetation cover may be used for spawning, foraging, and hiding. Various wildlife species are even dependent upon shoreline vegetation for their existence. Certain birds, such as marsh wrens (*Cistothorus palustris*) and endangered yellow-headed blackbirds (*Xanthocephalus xanthocephalus*) nest exclusively in emergent vegetation like cattails and bulrushes. Hosts of other wildlife like waterfowl, rails, herons, mink, and frogs to mention just a few, benefit from healthy stands of shoreline vegetation. Dragonflies, damselflies, and other beneficial invertebrates can be found thriving in vegetation along the shoreline as well. Two invertebrates of particular importance for lake management, the water-milfoil weevils (*Euhrychiopsis lecontei* and *Phytobius leucogaster*), which have been shown to naturally reduce stands of exotic Eurasian water-milfoil (*Myriophyllum spicatum*). Weevils need proper over wintering habitat such as leaf litter and mud which are typically found on naturalized shorelines or shores with good buffer strips. Many species of amphibians, birds, fish, mammals, reptiles, and invertebrates have suffered precipitous declines in recent years primarily due to habitat loss. Buffer strips may help many of these species and preserve the important diversity of life in and around lakes.

In addition to the benefits of increased fish and wildlife use, a buffer strip planted with a variety of native plants may provide a season long show of various colors from flowers, leaves, seeds, and stems. This is not only aesthetically pleasing to people, but also benefits wildlife and the overall health of the lake's ecosystem.

Cons

There are few disadvantages to native shoreline vegetation. Certain species (i.e., cattails) can be aggressive and may need to be controlled occasionally. If stands of shoreline vegetation become dense enough, access and visibility to the lake may be compromised to some degree. However, small paths could be cleared to provide lake access or smaller plants could be planted in these areas.

Costs

If minimal amount of site preparation is needed, costs can be approximately $15 per linear foot, plus labor. Cost of installing willow posts is approximately $20-25 per linear foot. The labor that is needed can be completed by the property owner in most cases, although consultants can be used to provide technical advice where needed. This cost will be higher if the area needs to be graded. If grading is necessary, appropriate permits and surveys are needed. If filling is required, additional costs will be incurred if compensatory storage is needed. The permitting process is costly, running as high as $1,500-2,000 depending on the types of permits needed.

<u>Option 5: Install A-Jacks®</u>

A-Jacks® are made of two pieces of pre-cast concrete when fitted together resemble a child's playing jacks. These structures are installed along the shoreline and covered with soil and/or an erosion control product. Native vegetation is then planted on the backfilled area. They can be used in areas where severe erosion does not justify a buffer strip alone.

Pros

The advantage to A-Jacks® is that they are quite strong and require low maintenance once installed. In addition, once native vegetation becomes established the A-Jacks® can not be seen. They provide many of the advantages that both rip-rap and buffer strips have. Specifically, they absorb some of the wave energy and protect the existing shoreline from additional erosion. The added benefit of a buffer strip gives the A-Jacks® a more natural appearance, which may provide wildlife habitat and help filter run-off nutrients, sediment, and pollutants. Less run-off entering a lake may have a positive effect on water quality.

Cons

The disadvantage is that installation cost can be high since labor is intensive and requires some heavy equipment. A-Jacks® need to be pre-made and hauled in from the manufacturing site. These assemblies are not as common as rip-rap, thus only a limited number of contractors may be willing to do the installation.

Costs

The cost of installation is approximately $50-75 per linear foot, but does not include permits and surveys, which can cost $1,500-2,000 and must be obtained prior to any work implementation. Additional costs will be incurred if compensatory storage is needed.

To repair the moderately eroding areas (411 feet) on Wooster Lake with A-Jacks® would cost approximately $20,550 – 30,825.

Option 6: Install Biolog, Fiber Roll, or Straw Blanket with Plantings

These products are long cylinders of compacted synthetic or natural fibers wrapped in mesh. The rolls are staked into shallow water. Once established, a buffer strip of native plants can be planted along side or on top of the roll (depending if rolls are made of synthetic or natural fibers). They are most effective in areas where plantings alone are not effective due to already severe erosion. In areas of severe erosion, other techniques may need to be employed or incorporated with these products.

Pros

Biologs, fiber rolls, and straw blankets provide erosion control that secure the shoreline in the short-term and allow native plants to establish which will eventually provide long-term shoreline stabilization. They are most often made of bio-degradable materials, which break down by the time the natural vegetation becomes established (generally within 3 years). They provide additional strength to the shoreline, absorb wave energy, and effectively filter run-off from terrestrial sources. These factors help improve water quality in the lake by reducing the amount of nutrients available for algae growth and by reducing the sediment that flows into a lake.

Cons

These products may not be as effective on highly erodible shorelines or in areas with steep slopes, as wave action may be severe enough to displace or undercut these products. On steep shorelines grading may be necessary to obtain a 2:1 or 3:1 slope or additional erosion control products may be needed. If grading or filling is needed, the appropriate permits and surveys will have to be obtained.

Costs

Costs range from $40 to $45 per linear foot of shoreline, including plantings. This does not include the necessary permits and surveys, which may cost $1,500 – 2,000 depending on the type of earthmoving that is being done. Additional costs may be incurred if compensatory storage is needed.

To repair the moderately eroding areas (411 feet) on Wooster Lake with biologs, fiber rolls, or straw blankets would cost approximately $16,440 – 18,495.

Option 7: Establish a "No Wake" Zone or No Motor Area

Establishing a "no wake" zone or no motor area will not solve erosion problems by itself. However, since shoreline erosion is generally not caused by one specific factor, these techniques can be effective if used in combination with one or more of the techniques described above.

A "no wake" zone is generally established in a defined area from the shoreline out to a certain point in a lake and is usually marked by buoys. This area should be sufficiently wide enough to allow wave action from boats to attenuate before reaching the shoreline. The size of the zone will depend on many factors including size and depth of the lake, the amount of shallow (<10 feet deep) areas, and the type of motors and boats used on the lake. No motor areas may be warranted on small shallow lakes or in areas of a lake that are particularly susceptible to erosion or otherwise need protection.

Wooster Lake currently has a "gentleman's agreement" of no wake on the entire lake. Although not enforceable, this policy should continue and educational efforts on the issue continue.

Pros

These techniques may reduce wave activity along shorelines susceptible to erosion. Limiting boat activity, particularly near shorelines or in shallow areas, may also have an additional benefit by improving water quality since less sediment may be disturbed and resuspended in the water column. Disturbed sediment contributes to poor water clarity, which can negatively effect sight feeding fish and wildlife and limit the available light needed for plant growth. Nuisance algae also benefit from disturbed sediment since this action makes available nutrients in the sediment that otherwise would stay settled on the bottom. This also may minimize plants being cut by boat props if the no wake buoys are outside plant beds.

Less motorboat disturbance will benefit wildlife and may encourage many species to use the lake both during spring and fall migration and for summer residence. This may add to the lake's aesthetics and increasing recreational opportunities for some lake users.

Cons

Enforcement and public education are the primary obstacles with these techniques. Public resistance to any regulation change may be strong, particularly if the lake is open to the public and has had no similar regulations in the past. Depending on the regulations implemented, there may be some loss of recreational use for some users, particularly powerboating. However, if the lake is large enough, certain parts of the lake (i.e., the middle or deepest) may be used for this activity without negatively influencing other uses.

Costs

Costs include the purchase and placement of signs, buoys, and enforcement, as well as maintenance of signs and buoys. No wake buoys cost approximately $35-150 each. Signs may cost $15-30 each.

Objective V: Eliminate or Control Exotic Species

Numerous exotic plant species have been introduced into our local ecosystems. Some of these plants are aggressive, quickly out-competing native vegetation and flourishing in an environment where few natural predators exist. Plants such as purple loosestrife (*Lythrum salicaria*), buckthorn (*Rhamnus cathartica*), and reed canary grass (*Phalaris arundinacea*) are three examples. The outcome is a loss of plant and animal diversity. This section will address terrestrial shoreline exotic species.

Purple loosestrife is responsible for the "sea of purple" seen along roadsides and in wetlands during summer. It can quickly dominate a wetland or shoreline. Due in part to an extensive root system, large seed production (estimates range from 100,000 to 2.7 million seeds per plant), and high seed germination rate, purple loosestrife spreads quickly. Buckthorn is an aggressive shrub species that grows along lake shorelines as well as most upland habitats. It shades out other plants, its roots exude a chemical that discourages other plant growth, and it is quick to become established on disturbed soils. Reed canary grass is an aggressive plant species that was introduced as a shoreline stabilizer. It is found on lakeshores, stream banks, marshes and exposed moist ground. Although it does serve to stabilize shorelines to some extent, it has low food value and does not provide winter habitat for wildlife. It is very successful in taking over disturbed areas and, if left unchecked, will dominate an area, particularly a wetland or shoreline, in a short period of time. Since it begins growing early in the spring, it quickly out-competes native vegetation that begins growth later in the year. Control of purple loosestrife, buckthorn, and reed canary grass are discussed below. However, these control measures can be similarly applied to other exotic species such as garlic mustard (*Allilaria officianalis*) or honeysuckle (*Lonicera* spp.) as well as some aggressive native species, such as box elder (*Acer negundo*).

The presence of exotic species along a lakeshore is by no means a death sentence for the lake or other plant and animal life. If controlled, many exotic species can perform many of the original functions that they were brought here for. For example, reed canary grass was imported for its erosion control properties. It still contributes to this objective (offering better erosion control than commercial turfgrass), but needs to be isolated and kept in control. Many exotics are the result of garden or ornamental plants escaping into the wild. One isolated plant along a shoreline will probably not create a problem by itself, but its removal early on is best. Problems arise when plants are left to spread, many times to the point where treatment is difficult or cost prohibitive. A monitoring program should be established, problem areas identified, and control measures taken when appropriate. This is particularly important in remote areas of lake shorelines where the spread of exotic species may go unnoticed for some time.

Option 1: No Action

No control will likely result in the expansion of the exotic species and the decline of native species. This option is not recommended if possible.

Pros
There are few advantages with this option. Some of the reasons exotics were brought into this country are no longer used or have limited use. However, in some cases having an exotic species growing along a shoreline may actually be preferable if the alternative plant is commercial turfgrass. Since turfgrass has shallow roots and is prone to erosion along shorelines, exotics like reed canary grass or common reed (*Phragmites australis*) will control erosion more effectively. Native plants should take precedent over exotics whenever possible. A table in Appendix A lists several native plants that can be planted along shorelines.

Cons
Native plant and wildlife diversity will be lost as stands of exotic species expand. Exotic species are not under the same stresses (particularly diseases and predators) as native plants and thus can out-compete the natives for nutrients, space, and light. Few wildlife species use areas where exotic plants dominate. This happens because many wildlife species either have not adapted with the plants and do not view them as a food resource, the plants are not digestible to the animal, or their primary food supply (i.e., insects) are not attracted to the plants. The result is a monoculture of exotic plants with limited biodiversity.

Recreational activities, especially wildlife viewing, may be hampered by such monocultures. Access to lake shorelines may be impaired due to dense stands of non-native plants. Other recreational activities, such as swimming and boating, may not be affected.

Costs
Costs with this option are zeroing initially, however, when control is eventually needed, costs will be substantially more than if action was taken immediately. Additionally, the eventual loss of ecological diversity is difficult to calculate financially.

<u>Option 2: Biological Control</u>

Biological control (bio-control) is a means of using natural relationships already in place to limit, stop, or reverse an exotic species' expansion. In most cases, insects that prey upon the exotic plants in its native ecosystem are imported. Since there is a danger of bringing another exotic species into the ecosystem, state and federal agencies require testing before any bio-control species are released or made available for purchase.

Recently two leaf beetles (*Galerucella pusilla* and *G. calmariensis*) and two weevils, one a root-feeder (*Hylobius transversovittatus*) and one a flower-feeder (*Nanophyes marmoratus*) have offered some hope to control purple loosestrife by natural means. These insects feed on the leaves, roots, or flowers of purple loosestrife, eventually weakening and killing the plant or, in the case of the flower-feeder, prevent seeding. In large stands of loosestrife, the beetles and weevils naturally reproduce and in many locations, significantly reduce plant densities. The insects are host specific, meaning that they will attack no other plant but purple loosestrife. Currently, the beetles have proven to be most effective and are available for purchase. There are no designated stocking rate recommendations, since using bio-control insects are seen as an inoculation and it may take 3-5 years for beetle populations to increase to levels that will cause significant damage. Depending on the size of the infested area, it may take 1,000 or more adult beetles per acre to cause significant damage.

Around Wooster Lake, purple loosestrife is not a problem at this time. However, this option is included in this report for future reference.

Pros

Control of exotics by a natural mechanism is preferable to chemical treatments. Insects, being part of the same ecological system as the exotic plant (i.e., the beetles and weevils and the purple loosestrife) are more likely to provide long-term control. Chemical treatments are usually non-selective while bio-control measures target specific plant species. This technique is beneficial to the ecosystem since it preserves, even promotes, biodiversity. As the exotic plant dies back, native vegetation can reestablish the area.

Cons

Few exotics can be controlled using biological means. Currently, there are no bio-control techniques for plants such as buckthorn, reed canary grass, or a host of other exotics. One of the major disadvantages of using bio-control is the costs and labor associated with it.

Use of biological mechanisms to control plants such as purple loosestrife is still under debate. Similar to purple loosestrife, the beetles and weevils that control it are not native to North America. Due to the poor historical record of introducing non-native species, even to control other non-native species, this technique has its critics.

Costs

The New York Department of Natural Resources at Cornell University (email: bb22@cornell.edu, 607-255-5314, or visit the website: www.invasiveplants.net) sells overwintering adult leaf beetles (which will lay eggs the year of release) for $1 per beetle and new generation leaf beetles (which will lay eggs beginning the following year) at $0.25 per beetle. The root beetles are sold for $5 per beetle. Some beetles may be available for free by contacting the Illinois Natural History Survey (INHS; 217-333-6846). The INHS also conducts a workshop each spring at Volo Bog for individuals and groups interested in learning how to rear their own beetles.

Option 3: Control by Hand

Controlling exotic plants by hand removal is most effective on small areas (< 1 acre) and if done prior to heavy infestation. Some exotics, such as purple loosestrife and reed canary grass, can be controlled to some degree by digging, cutting, or mowing if done early and often during the year. Digging may be required to ensure the entire root mass is removed. Spring or summer is the best time to cut or mow, since late summer and fall is when many of the plant seeds disperse. Proper disposal of excavated plants is important since seeds may persist and germinate even after several years. Once exotic plants are removed, the disturbed ground should be planted with native vegetation and closely monitored since regrowth is common. Many exotic species, such as purple loosestrife, buckthorn, and garlic mustard are proficient at colonizing disturbed sites.

Pros
Removal of exotics by hand eliminates the need for chemical treatments. Costs are low if stands of plants are not too large already. Once removed, control is simple with yearly maintenance. Control or elimination of exotics preserves the ecosystem's biodiversity. This will have positive impacts on plant and wildlife presence as well as some recreational activities.

Cons
This option may be labor intensive or prohibitive if the exotic plant is already well established. Costs may be high if large numbers of people are needed to remove plants. Soil disturbance may introduce additional problems such as providing a seedbed for other non-native plants that quickly establish disturbed sites, or cause soil-laden run-off to flow into nearby lakes or streams. In addition, a well-established stand of an exotic like purple loosestrife or reed canary grass may require several years of intense removal to control or eliminate.

Costs
Cost for this option is primarily in tools, labor, and proper plant disposal.

Option 4: Herbicide Treatment
Chemical treatments can be effective at controlling exotic plant species. However, chemical treatment works best on individual plants or small areas already infested with the plant. In some areas where individual spot treatments are prohibitive or impractical (i.e., large expanses of a wetland or woodland), chemical treatments may not be an option because in order to chemically treat the area, a broadcast application would be needed. Because many of the herbicides are not selective, meaning they kill all plants they contact, this may be unacceptable if native plants are found in the proposed treatment area.

Herbicides are commonly used to control nuisance shoreline vegetation such as buckthorn and purple loosestrife. Herbicides are applied to green foliage or cut stems. Products are applied by either spraying or wicking (wiping) solution on plant surfaces. Spraying is used when large patches of undesirable vegetation are targeted. Herbicides are sprayed on growing foliage using a hand-held or backpack sprayer. Wicking is used when selected plants are to be removed from a group of plants. The herbicide solution is wiped on foliage, bark, or cut stems using an herbicide-soaked device. Trees are normally treated by cutting off a ring of bark around the trunk (called girdling). Herbicides are applied onto the ring at high concentrations. Other devices inject the herbicide through the bark. It is best to apply herbicides when plants are actively growing, such as in the late spring/early summer, but before formation of seed heads. Herbicides are often used in conjunction with other methods, such as cutting or mowing, to achieve the best results. Proper use of these products is critical to their success. Always read and follow label directions.

Pros

Herbicides provide a fast and effective way to control or eliminate nuisance vegetation. Unlike other control methods, herbicides kill the root of the plant, which prevents regrowth. If applied properly, herbicides can be selective. This allows for removal of selected plants within a mix of desirable and undesirable plants.

Cons

Since most herbicides are non-selective, they are not suitable for broadcast application. Thus, chemical treatment of large stands of exotic species may not be practical. Native species are likely to be killed inadvertently and replaced by other non-native species. Off target injury/death may result from the improper use of herbicides. If herbicides are applied in windy conditions, chemicals may drift onto desirable vegetation. Care must also be taken when wicking herbicides as not to drip on to non-targeted vegetation such as native grasses and wildflowers. Another drawback to herbicide use relates to their ecological soundness and the public perception of them. Costs may also be prohibitive if plant stands are large. Depending on the device, cost of the application equipment can be high.

Costs

Two common herbicides, triclopyr (sold as Garlon ™) and glyphosate (sold as Rodeo®, Round-up™, Eagre™, or AquaPro™), are sold in 2.5 gallon jugs, and cost approximately $200 and $350, respectively. Only Rodeo® is approved for water use. A Hydrohatchet®, a hatchet that injects herbicide through the bark, is about $300.00. Another injecting device, E-Z Ject® is $450.00. Hand-held and backpack sprayers costs from $25-$45 and $80-150, respectively. Wicking devices are $30-40. A girdling tool costs about $150.

Objective VI: Enhance Wildlife Habitat Conditions

The key to increasing wildlife species in and around a lake can be summed up in one word: habitat. Wildlife need the same four things all living creatures need: food, water, shelter, and a place to raise their young. Since each wildlife species has specific habitat requirements, which fulfill these four basic needs, providing a variety of habitats will increase the chance that wildlife species may use an area. Groups of wildlife are often associated with the types of habitats they use. For example, grassland habitats may attract wildlife such as northern harriers, bobolinks, meadowlarks, meadow voles, and leopard frogs. Marsh habitats may attract yellow-headed blackbirds and sora rails, while manicured residential lawns attract house sparrows and gray squirrels. Thus, in order to attract a variety of wildlife, a mix of habitats are needed. In most cases quality is more important than quantity (i.e., five 0.1-acre plots of different habitats may not attract as many wildlife species than one 0.5 acre of one habitat type).

It is important to understand that the natural world is constantly changing. Habitats change or naturally succeed to other types of habitats. For example, grasses may be succeeded by shrub or shade intolerant tree species (e.g., willows, locust, and cottonwood). The point at which one habitat changes to another is rarely clear, since these changes usually occur over long periods of time, except in the case of dramatic events such as fire or flood.

In all cases, the best wildlife habitats are ones consisting of native plants. Unfortunately, non-native plants dominate many of our lake shorelines. Many of them escaped from gardens and landscaped yards (i.e., purple loosestrife) while others were introduced at some point to solve a problem (i.e., reed canary grass for erosion control). Wildlife species prefer native plants for food, shelter, and raising their young. In fact, one study showed that plant and animal diversity was 500% higher along naturalized shorelines compared to shorelines with conventional lawns (University of Wisconsin – Extension, 1999).

<u>Option 1: No Action</u>

This option means that the current land use activities will continue. No additional techniques will be implemented. Allowing a field to go fallow or not mowing a manicured lawn would be considered an action.

> ***Pros***
>
> Taking no action may maintain the current habitat conditions and wildlife species present, depending on environmental conditions and pending land use actions. If all things remain constant there will be little to no effect on lake water quality and other lake uses.
>
> ***Cons***
>
> If environmental conditions change or substantial land use actions occur (i.e., development) wildlife use of the area may change. For example, if a new housing

development with manicured lawns and roads is built next to an undeveloped property, there will probably be a change in wildlife present.

Conditions in the lake (i.e., siltation or nutrient loading) may also change the composition of aquatic plant and invertebrate communities and thus influence biodiversity. Siltation and nutrient loading will likely decrease water clarity, increase turbidity, increase algal growth (due to nutrient availability), and decrease habitat for fish and wildlife.

Costs

The financial cost of this option may be zero. However, due to continual loss of habitats many wildlife species have suffered drastic declines in recent years. The loss of habitat affects the overall health and biodiversity of the lake's ecosystems.

Option 2: Increase Habitat Cover

This option can be incorporated with Option 3 (see below). One of the best ways to increase habitat cover is to leave a minimum 25-foot buffer between the edge of the water and any mowed grass. Allow native plants to grow or plant native vegetation along shorelines, including emergent vegetation such as cattails, rushes, and bulrushes (see the table in Appendix A for costs and seeding rates). This will provide cover from predators and provide nesting structure for many wildlife species and their prey. It is important to control or eliminate non-native plants such as buckthorn, purple loosestrife, garlic mustard, and reed canary grass, since these species outcompete native plants and provide little value for wildlife.

Occasionally high mowing (with the mower set at its highest setting) may have to be done for specific plants, particularly if the area is newly established, since competition from weedy and exotic species is highest in the first couple years. If mowing, do not mow the buffer strip until after July 15 of each year. This will allow nesting birds to complete their breeding cycle.

Brush piles make excellent wildlife habitat. They provide cover as well as food resources for many species. Brush piles are easy to create and will last for several years. They should be place at least 10 feet away from the shoreline to prevent any debris from washing into the lake.

Trees that have fallen on the ground or into the water are beneficial by harboring food and providing cover for many wildlife species. In a lake, fallen trees provide excellent cover for fish, basking sites for turtles, and perches for herons and egrets.

Increasing habitat cover should not be limited to the terrestrial environment. Native aquatic vegetation, particularly along the shoreline, can provide cover for fish and other wildlife.

Pros
Increased cover will lead to increased use by wildlife. Since cover is one of the most important elements required by most species, providing cover will increase the chances of wildlife using the shoreline. Once cover is established, wildlife usually have little problem finding food, since many of the same plants that provide cover also supply the food the wildlife eat, either directly (seeds, fruit, roots, or leaves) or indirectly (prey attracted to the plants).

Additional benefits of leaving a buffer include: stabilizing shorelines, reducing runoff which may lead to better water quality, and deterring nuisance Canada geese. Shorelines with erosion problems can benefit from a buffer zone because native plants have deeper root structures and hold the soil more effectively than conventional turfgrass. Buffers also absorb much of the wave energy that batters the shoreline. Water quality may be improved by the filtering of nutrients, sediment, and pollutants in run-off. This has a "domino effect" since less run-off flowing into a lake means less nutrient availability for nuisance algae, and less sediment means less turbidity, which leads to better water quality. All this is beneficial for fish and wildlife, such as sight-feeders like bass and herons, as well as people who use the lake for recreation. Finally, a buffer strip along the shoreline can serve as a deterrent to Canada geese from using a shoreline. Canada geese like flat, open areas with a wide field of vision. Ideal habitat for them are areas that have short grass up to the edge of the lake. If a buffer is allowed to grow tall, geese may choose to move elsewhere.

Cons
There are few disadvantages to this option. However, if vegetation is allowed to grow, lake access and visibility may be limited. If this occurs, a small path can be made to the shoreline. Composition and density of aquatic and shoreline vegetation are important. If vegetation consists of non-native species such as or Eurasian water milfoil or purple loosestrife, or in excess amounts, undesirable conditions may result. A shoreline with excess exotic plant growth may result in a poor fishery (exhibited by stunted fish) and poor recreation opportunities (i.e., boating, swimming, or wildlife viewing).

Costs
The cost of this option would be minimal. The purchase of native plants can vary depending upon species and quantity. Based upon 100 feet of shoreline, a 25-foot buffer planted with a native forb and grass seed mix would cost between $165-270 (2500 sq. ft. would require 2.5, 1000 sq. ft. seed mix packages at $66-108 per package). This does not include labor that would be needed to prepare the site for planting and follow-up maintenance. This cost can be reduced or minimized if native plants are allowed to grow. However, additional time and labor may be needed to insure other exotic species, such as buckthorn, reed canary grass, and purple loosestrife, do not become established.

Option 3: Increase Natural Food Supply

This can be accomplished in conjunction with Option 2. Habitats with a diversity of native plants will provide an ample food supply for wildlife. Food comes in a variety of forms, from seeds to leaves or roots to invertebrates that live on or are attracted to the plants. Plants found in the table in Appendix A should be planted or allowed to grow. In addition, encourage native aquatic vegetation, such as water lily (*Nuphar* spp. and *Nymphaea tuberosa*), sago pondweed (*Stuckenia pectinatus*), largeleaf pondweed (*Potamogeton amplifolius)*, and wild celery (*Vallisneria americana*) to grow. Aquatic plants such as these are particularly important to waterfowl in the spring and fall, as they replenish energy reserves lost during migration.

Providing a natural food source in and around a lake starts with good water quality. Water quality is important to all life forms in a lake. If there is good water quality, the fishery benefits and subsequently so does the wildlife (and people) who prey on the fish. Insect populations in the area, including beneficial predatory insects, such as dragonflies, thrive in lakes with good water quality.

Dead or dying plant material can be a source of food for wildlife. A dead standing or fallen tree will harbor good populations of insects for woodpeckers, while a pile of brush may provide insects for several species of songbirds such as warblers and flycatchers.

Supplying natural foods artificially (i.e., birdfeeders, nectar feeders, corn cobs, etc.) will attract wildlife and in most cases does not harm the animals. However, "people food" such as bread should be avoided. Care should be given to maintain clean feeders and birdbaths to minimize disease outbreaks.

Pros

Providing food for wildlife will increase the likelihood they will use the area. Providing wildlife with natural food sources has many benefits. Wildlife attracted to a lake can serve the lake and its residents well, since many wildlife species (i.e., many birds, bats, and other insects) are predators of nuisance insects such as mosquitoes, biting flies, and garden and yard pests (such as certain moths and beetles). Effective natural insect control eliminates the need for chemical treatments or use of electrical "bug zappers" that have limited effect on nuisance insects.

Migrating wildlife can be attracted with a natural food supply, primarily from seeds, but also from insects, aquatic plants or small fish. In fact, most migrating birds are dependent on food sources along their migration routes to replenish lost energy reserves. This may present an opportunity to view various species that would otherwise not be seen during the summer or winter.

Cons

Feeding wildlife can have adverse consequences if populations become dependent on hand-outs or populations of wildlife exceed healthy numbers. This frequently happens when people feed waterfowl like Canada geese or mallard ducks.

Feeding these waterfowl can lead to a domestication of these animals. As a result, these birds do not migrate and can contribute to numerous problems, such as excess feces, which is both a nuisance to property owners and a significant contribution to the lake's nutrient load. Waterfowl feces are particularly high in phosphorus. Since phosphorus is generally the limiting factor for nuisance algae growth in many lakes in the Midwest, the addition of large amounts of this nutrient from waterfowl may exacerbate a lake's excessive algae problem. In addition, high populations of birds in an area can increase the risk of disease for not only the resident birds, but also wild bird populations that visit the area.

Finally, tall plants along the shoreline may limit lake access or visibility for property owners. If this occurs, a path leading to the lake could be created or shorter plants may be used in the viewing area.

Costs
The costs of this option are minimal. The purchase of native plants and food and the time and labor required to plant and maintain would be the limit of the expense.

Option 4: Increase Nest Availability
Wildlife are attracted by habitats that serve as a place to raise their young. Habitats can vary from open grasslands to closed woodlands (similar to Options 2 and 3).

Standing dead or dying trees provide excellent habitat for a variety of wildlife species. Birds such as swallows, woodpeckers, and some waterfowl need dead trees to nest in. Generally, a cavity created and used by a woodpecker (e.g., red-headed or downy woodpecker, or common flicker) in one year, will in subsequent years be used by species like tree swallows or chickadees. Over time, older cavities may be large enough for waterfowl, like wood ducks, or mammals (e.g., flying squirrels) to use. Standing dead trees are also favored habitat for nesting wading birds, such as great blue herons, night herons, and double-crested cormorants, which build stick nests on limbs. For these birds, dead trees in groups or clumps are preferred as most herons and cormorants are colonial nesters.

In addition to allowing dead and dying trees to remain, erecting bird boxes will increase nesting sites for many bird species. Box sizes should vary to accommodate various species. Swallows, bluebirds, and other cavity nesting birds can be attracted to the area using small artificial nest boxes. Larger boxes will attract species such as wood ducks, flickers, and owls. A colony of purple martins can be attracted with a purple martin house, which has multiple cavity holes, placed in an open area near water.

Bat houses are also recommended for any area close to water. Bats are voracious predators of insects and are naturally attracted to bodies of water. They can be enticed into roosting in the area by the placement of bat boxes. Boxes should be constructed of rough non-treated lumber and placed >10 feet high in a sunny location.

Pros
Providing places were wildlife can rear their young has many benefits. Watching wildlife raise their young can be an excellent educational tool for both young and old.

The presence of certain wildlife species can help in controlling nuisance insects like mosquitoes, biting flies, and garden and yard pests. This eliminates the need for chemical treatments or electric “bug zappers” for pest control.

Various wildlife species populations have dramatically declined in recent years. Since, the overall health of ecosystems depend, in part, on the role of many of these species, providing sites for wildlife to raise their young will benefit not only the animals themselves, but the entire lake ecosystem.

Cons
Providing sites for wildlife to raise their young have few disadvantages. Safety precautions should be taken with leaving dead and dying trees due to the potential of falling limbs. Safety is also important when around wildlife with young, since many animals are protective of their young. Most actions by adult animals are simply threats and are rarely carried out as attacks.

Parental wildlife may chase off other animals of its own species or even other species. This may limit the number of animals in the area for the duration of the breeding season.

Costs
The costs of leaving dead and dying trees are minimal. The costs of installing the bird and bat boxes vary. Bird boxes can range in price from $10-100.00. Purple martin houses can cost $50-150. Bat boxes range in price from $15-50.00. These prices do not include mounting poles or installation.

Option 5: Limit Disturbance
Since most species of wildlife are susceptible to human disturbance, any action to curtail disturbances will be beneficial. Limiting disturbance can include posting signs in areas of the lake where wildlife may live (e.g., nesting waterfowl), establish a “no wake” area, boat horsepower or speed limits, or establish restricted boating hours. These are examples of time and space zoning for lake usage. Enforcement and public education are needed if this option is to be successful. In some areas, off-duty law enforcement officers can be hired to patrol the lake.

Pros
Limiting disturbance will increase the chance that wildlife will use the lake, particularly for raising their young. Many wildlife species have suffered population declines due to loss of habitat and poor breeding success. This is due in part to their sensitivity to disturbance.

This option also can benefit the lake in other ways. Limited boat traffic may lead to less wave action to batter shorelines and cause erosion, which results in suspension of nutrients and sediment in the water column. Less nutrients and sediment in the water column may improve water quality by increasing water clarity and limiting nutrient availability for excessive plant or algae growth.

Recreation activities such as canoeing and paddleboating may be enhanced by the limited disturbance.

Cons
One of the strongest oppositions to this option would probably be from the powerboat users and water skiers. However, this problem may be solved if a significant portion of the daylight hours and the use of the middle part of the lake (assuming the lake is deep enough) are allowed for powerboating. For example, powerboating could be allowed between 9 AM and 6 PM within the boundaries established by "no wake" restricted area buoys.

Costs
The costs of this option include the purchase and placement of signs and public educational materials as well as enforcement. Off-duty law enforcement officers usually charge $25/hour to enforce boating laws or local ordinances.

Objective VII: Canada Geese and Waterfowl

This objective focuses primarily on Canada geese, but the premise is applicable to other waterfowl such as domesticated or semi-domesticated geese, ducks, or swans. In Wooster Lake this objective is meant to address the large numbers of semi-domesticated ducks and non-native mute swans present on the lake.

Canada geese and are one of many migratory waterfowl common throughout North America. Geese and other domesticated waterfowl in urban areas can be undesirable primarily due to the large amount of feces they leave behind. Recreational activities on lawns and parks are impeded due to waterfowl feces. Large amounts of feces may end up in the water, either directly from geese on the water or rainwater runoff from lawns where feces have accumulated. Waterfowl feces is high in organic phosphorus. High nutrient levels, particularly phosphorus, can contribute to excessive algae growth in lakes. This may inhibit other recreational activities such as boating or swimming, as well as create poor habitat for fish and wildlife, and possibly bad odors when the algae decays.

Geese and domesticated waterfowl become problematic for many reasons. They seek locations that have open water, adequate food supplies, and safety from predators. If these factors are present, geese may not migrate. Since geese exhibit a high level of site fidelity, they return to (or stay at) the same area each year. Thus, adults will likely come back to the same area year after year to nest. If conditions remain optimal, one pair of geese can quickly multiply causing additional problems. Increased development in Lake County has inadvertently created ideal habitat for goose populations. Manicured lawns mowed to the edge of lakes and detention ponds provide geese with open areas with ample food and security. Other conditions that encourage goose residency include open water during winter (primarily the result of aerators in lakes and ponds), mild winters, and people feeding birds with bread or similar human food.

Large populations of domesticated waterfowl pose a potential disease threat both to resident and wild populations of waterfowl. This problem may be more serious in residential populations since these birds stay in one area for long periods of time are more likely to transmit any disease to neighboring groups of waterfowl. There is no threat of disease transmission to humans or domestic dogs and cats since most of the diseases are specific to birds.

<u>Option 1: No Action</u>

Pros

This option has no costs, however, increasing numbers of waterfowl will most likely exacerbate existing problems and probably create new ones, which in the future may cost more than if the problems are addressed immediately.

Cons

If current conditions continue and no action is taken, numbers of waterfowl and problems associated with them will likely increase. An increase of goose feces washed into a lake will increase the lake's nutrient load and eventually may have a detrimental impact on water quality through excessive algae growth. One study (Manny et al. 1975) documented that each goose excretes 0.072 lbs of feces per day. This may not seem like a significant amount, but if 100 geese are present (many lakes in the county can experience 1,000 or more at a time) that equates to over 7 lbs of feces per day! Algae blooms may negatively impact recreational uses such as swimming, boating, and fishing. In addition, when algae dies, odor problems and depleted oxygen levels in the water occur. Increased numbers of geese may also result in overgrazed areas of grass.

Costs

There are a few short-term financial costs with this option. Costs of cleaning feces off lawns or piers are probably more psychological or physical than financial. Long-term costs may be more indirect, including increased nutrient deposition into lakes which may promote excessive algae and plants. Costs incurred may include money needed to control algae with algaecides.

Option 2: Removal

Since Canada Geese are considered migratory waterfowl, both state and federal laws restrict taking or harassing geese. Under the federal Migratory Bird Treaty Act, it is illegal to kill or capture geese outside a legal hunting season or to harass their nests without a permit. If removal of problematic geese is warranted or if nest and egg destruction is an option, permits need to be obtained from the Illinois Department of Natural Resources (217- 782-6384) and the U.S. Fish and Wildlife Service (217-241-6700).

Hunting is one of the most effective techniques used in goose management. However, since many municipalities have ordinances prohibiting the discharge of firearms, reduction of goose numbers by hunting in urban areas (i.e., lakes, ponds, and parks) may not be an option. Hunting does occur on many lakes in the county, but certain regulations apply (e.g., 100 yard minimum distance from any residential property). Contact the Illinois Department of Natural Resources for dates and regulations regarding the waterfowl hunting seasons. Also, contact local and county law enforcement agencies regarding any ordinances concerning hunting within municipal boundaries.

Egg addling, or destroying the egg by shaking, piercing, or freezing, can be used to reduce or eliminate a successful clutch. Eggs should be returned to the nest so the hen goose does not re-lay another clutch. However, if no eggs hatch, she may still lay another clutch. Leaving one or two eggs unaltered and allowing them to hatch may prevent another clutch from being laid and reduces the total year's reproduction. Egg addling requires a state and federal permit.

The capture and relocation of geese is no longer a desirable option. First, relocated geese may return to the same location where they were captured. Second, there is a concern over potential disease transmission from relocated geese to other goose populations.

Finally, since goose numbers in Illinois are already high there is no need to supplement other populations in the area.

Pros
Removing a significant portion of a problem goose population can have a positive effect on the overall health of a lake. Reduction of feces on lawns and parks is beneficial to recreation users of all types. Less feces in the water means less phosphorus available for nuisance plant and algae growth. Thus, the overall water quality of the lake may be improved by this reduction in phosphorus.

Cons
If the habitat conditions still exist, more geese will likely replace any that were removed. Thus, money and time used removing geese may not be well spent unless there is a change in habitat conditions.

Costs
A Illinois residential waterfowl hunting license (including state and federal waterfowl stamps) is $39.00 for the 2002-2003 hunting season. For depredation permits, there is a $25 fee for the federal permit. Once the federal permit is issued the state permit can be obtained at no charge.

Option 3: Dispersal/Repellent Techniques
Several techniques and products are on the market that claim to disperse or deter geese from using an area. These techniques can be divided into two categories: harassment and chemical. With both types of techniques it is important to implement any action early in the season, before geese establish territories and begin nesting. Once established, the dispersal/repellant techniques may be less effective and geese more difficult to coerce into leaving.

The goal with harassment techniques is to frighten geese from an area using sounds or objects. Various products are available that simulate natural predators (i.e., plastic hawks and owls) or otherwise make geese nervous (i.e., balloons, shiny tape, and flags). Other products emit noises, such as propane cannons, which can be set on a timer to go off at programmed intervals (e.g., every 20-30 seconds), or recorded goose distress calls which can be played back over a loudspeaker or tape player. Over time these techniques may be ineffective, since geese become acclimated to these devices. Most of these products are more effective when used in combination with other techniques.

Another technique that has become popular is using dogs or swans to harass geese. Dogs can be used primarily in the spring and fall to keep birds from using an area by herding or chasing geese away from a particular area. Any dogs used for this purpose should be well trained and under the owners control at all times. Professional trainers can be contracted to use their dogs for this purpose. Dogs should not be used during the summer when geese are unable to fly due to molting. Swans are used because they are naturally aggressive in defending their territory, including chasing other waterfowl away from their nesting area. Since wild swans cannot be used for this technique, non-native mute swans are used. However, mute swans are not as aggressive and in some case are permissive of geese. Again, using a combination of techniques would be most effective.

Chemical repellents can be used with some effectiveness. New products are continually coming out that claim to rid an area of nuisance geese. Several products (ReJeX-iT® and GooseChase™) are made from methyl-anthranilate, a natural occurring compound, and can be sprayed on areas where geese are feeding. The spray makes the grass distasteful and forces geese to move elsewhere to feed. Another product, Flight Control™, works similarly, but has the additional benefit of absorbing ultra violet light making the grass appear as if it was not a food source. The sprays need to be reapplied every 14-30 days, depending upon weather conditions and mowing frequency.

Pros

With persistence, harassment and/or use of repellants can result in reduced or minimal usage of an area by geese. Fewer geese may mean less feces and cleaner yards and parks, which may increase recreational uses along shorelines. If large numbers of geese were once present, the reduction of fecal deposits into the lake may help minimize the amount of phosphorus entering the water. Less phosphorus in the water means less "food" available for plant and algae growth, which may have a positive effect of water quality. Finally, any areas overgrazed by geese may have a chance to recover.

Cons

The effectiveness of harassment techniques is reduced over time since geese will adapt to the devices. However, their effectiveness can be extended if the devices are moved to different locations periodically, or used in conjunction with other techniques.

Use of dogs can be time consuming, since the dog must be trained and taken care of. Dogs must also be used frequently in the beginning of the season to be effective at deterring geese. This requires time of the dog owner as well. Dogs (frequently herding dogs, like border collies) that are effective at harassing or herding geese are typically may not be the best pets for the average homeowner. They are bred as working dogs and consequently have high levels of energy that requires the owner's attention.

Repelling or chasing away geese from an area only solves the goose problem for that area and most likely moves the geese (and the problem) to another area. As long as there is suitable habitat nearby, the geese will not wander very far.

Costs

Costs for the propane cannons are approximately $660 ($360 for the cannon, $300 for a timer), not including the propane tank. The cost of ReJeX-iT® is $80/gallon, GooseChase™ is $95/gallon, and Flight Control™ costs $200/gallon. One gallon covers one acre of turf using ReJeX-iT® and, GooseChase™, and two acres using Flight Control™.

Option 4: Exclusion

Erecting a barrier to exclude geese is another option. In addition to a traditional wood or wire fence, an effective exclusion control is to suspend netting over the area where geese are unwanted. Geese are reluctant to fly or walk into the area. A similar deterrent that is often used is a single string or wire suspended a foot or so above the ground along the length of the shoreline.

> ***Pros***
> Depending on the type of barrier used, areas of exclusion will have less fecal mess and may have higher recreational uses. Vegetation that was overgrazed by geese may also be able to recover.
>
> ***Cons***
> This technique will not be effective if the geese are using a large area. Also, use of the area by people is severely limited if netting is installed. Fences can also limit recreational uses. The single string or wire method may be effective at first, but geese often learn to go around, over, or under the string after a short period of time. Finally, excluding geese from one area will force them to another area on a different part of the same lake or another nearby lake. While this solves one property owners problem, it creates one (or makes one worse) for another. Also, problems associated with excess feces entering the lake (i.e., increased phosphorus levels) will continue.
>
> ***Costs***
> The costs of these techniques are minimal, unless a wood or wire fence is constructed. String, wire, or netting can be purchased or made from materials at local stores.

Option 5: Habitat Alteration

One of the best methods to deter geese from using an area is through habitat alteration. Habitats that consist of mowed turfgrass to the edge of the shoreline are ideal for geese. Low vegetation near the water allows geese to feed and provides a wide view with which to see potential predators. In general, geese do not favor habitats with tall vegetation. To achieve this, create a buffer strip (approximately 10-20 feet wide) between the shoreline and any mowed lawn. Planting natural shoreline vegetation (i.e., bulrushes, cattails, rushes, grasses, shrubs, and trees, etc.) or allowing the vegetation to establish naturally can create buffer strips. A table in Appendix A has a list of native plants, seeding rates, and approximate costs that can be used when creating buffer strips.

Geese prefer ponds and lakes that have shorelines with gentle slopes to ones with steep slopes. While this alone will not prevent geese from using an area, steeper slopes used along with other techniques will be more effective. This option may not be practical for existing lake shorelines since any grading and/or filling would require permits and surveys, which would drive up the costs of redoing the shoreline considerably.

Aeration systems that run into the fall and winter prevent the lake from freezing, thus not forcing geese to migrate elsewhere. To alleviate this problem, turn aerators off during fall and early winter. Once the lake freezes over and the geese have left, wait a few weeks before turning the aerators on again if needed.

Pros

Altering the habitat in an area can not only make the habitat less desirable for geese, but may be more desirable for many other species of wildlife. A buffer strip has additional benefits by filtering run-off of nutrients, sediments, and pollutants and protecting the shoreline from erosion from wind, wave, or ice action. Finally, the greater the area that vegetated naturally, the less turfgrass that needs to be constantly manicured and maintained.

Cons

Converting a portion or all of an area to tall grass or shrub habitat may reduce the lake access or visibility. However, if this occurs, a small path can be made to the lake or shorter plants may be used at the access location in the buffer strip.

Costs

If minimal amount of site preparation is needed to create a buffer strip, costs can be approximately $10 per linear foot, plus labor. The labor that is needed can be completed by the property owner in most cases, although consultants can be used to provide technical advice where needed. This cost will be higher if the area needs to be graded. If grading is necessary, appropriate permits and surveys are needed. If filling is required, additional costs will be incurred if compensatory storage is needed. Compensatory storage is the process of excavating in a portion of a property or floodplain to compensate for the filling in of another portion of the floodplain. The permitting process is costly, running as high as $1,000-2,000 depending on the types of permits needed.

Once established, a buffer strip of native plants needs little maintenance. If aerators are not run for several months, there will be a reduction in electrical costs.

<u>Option 6: Do Not Feed Waterfowl!</u>

There are few "good things", if any, that come from feeding waterfowl. Birds become dependent on handouts, become semi-domesticated, and do not migrate. This causes populations to increase and concentrate, which may create additional problems such as diseases within waterfowl populations. The nutritional value in many of the "foods" (i.e., white bread) given to geese and other waterfowl are quite low. Since geese are physiologically adapted to eat a variety of foods, they can actually be harmed by filling-up on human food. Geese that are accustom to hand feeding may become aggressive toward other geese or even the people feeding the geese.

Costs
There are no costs to this option, except the public education that is needed to encourage people not to feed waterfowl. In some cases, signs could be posted to discourage waterfowl feeding.

Reference:
Manny, B. A., R. G. Wetzel, and W. C. Johnson. 1975. Annual contribution of carbon, nitrogen, and phosphorus by migrant Canada geese to a hardwater lake. Verh. Internat. Verein. Limnol. 19:949-951.